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Ministry of Northern Development and Mines
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Geology of

Carbonatite – Alkalic Rock Complexes in Ontario:

Argor Carbonatite Complex

District of Cochrane

Ontario Geological Survey
Study 41

by R. P. Sage

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Foreword

The Argor Carbonatite Complex was examined as part of a project to study alkalic rock – carbonatite complexes in Ontario. The study describes the rock types and mineralogy of the complex and outlines the history of the mineral exploration efforts within the complex.

V.G. Milne

Director
Ontario Geological Survey

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CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in cooperation with the Coal Association of Canada.

Geology of
Carbonatite – Alkalic Rock Complexes in Ontario:
Argor Carbonatite Complex
District of Cochrane

R.P. Sage[1]

1. Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto. Manuscript approved for publication, November 25, 1983, by John Wood, Chief Geologist, Ontario Geological Survey.

This report is published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Abstract

The Argor Carbonatite Complex lies at the north end of the Kapuskasing Subprovince of the Superior Province of the Canadian Shield. The north end of the Kapuskasing Subprovince consists of gneisses metamorphosed to the granulite facies rank. The Argor Carbonatite Complex consists of a carbonate–rich core of sovite and silicocarbonatite enclosed in a pyroxenite–hornblendite rim. The complex is dike–like in plan view and has a north–south strike. The intrusion was likely emplaced into a north–trending fault zone.

Petrography indicates the complex has undergone deformation and recrystallization. A potassium–argon isotopic age indicates a Proterozoic age of 1655 Ma for the complex.

The complex has been subjected to intense exploration and contains a drill indicated deposit of 62,000,000 tons grading 0.52 percent Nb_2O_5. The complex has potential for by–product apatite and possibly for by–product zircon mineralization.

Résumé

Le complexe de carbonatite Argor est situé dans la partie nord de la sous–province de Kapuskasing, dans la province Supérieure du bouclier canadien. Cette partie est formée de gneiss métamorphosés en faciès à granulites. Le complexe est formé d'un noyau riche en carbonate, en sovite et en silicocarbonatite et entouré de pyroxénite et de hornblendite. Vu en plan, le complexe est semblable à un dyke et est orienté nord–sud. L'intrusion était sans doute placée dans une zone de faille orientée vers le nord.

La pétrographie révèle que le complexe a subi une déformation et une recristallisation. D'après les techniques isotopiques de datation au potassium et à l'argon, le complexe serait de l'ère protérozoique et son âge serait de 1655 Ma.

Le complexe a fait l'objet d'une prospection intense et, d'après le forage effectué, contient un dépôt de 62 000 000 de tonnes dont la teneur en Nb_2O_5 est de 0,52 pour 100. L'apatite figure parmi les sous–produits potentiels du complexe et le zircon pourrait faire l'objet d'une minéralisation.

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Introduction

As part of a study of carbonatite – alkalic rock complexes in Ontario, a brief examination was made of a selected group of thin sections of diamond drill core from the Argor Carbonatite Complex. The complex was emplaced into the northern portion of the Kapuskasing Subprovince of the Canadian Shield and is located at the edge of the Paleozoic cover rocks that form the bedrock to most of the James Bay Lowlands. The carbonatite is one of several in the northern part of the Kapuskasing Subprovince and was likely emplaced into a fault zone. The carbonatite was discovered by a consortium of companies which flew aeromagnetic surveys over areas covered by licences of occupation. Diamond drilling by the consortium has outlined a large deposit of pyrochlore–bearing carbonatite that promises to have future economic potential. The complex consists of pyroxenite–hornblendite, silicocarbonatite and sovite and is one of a group of Proterozoic (Middle Precambrian) carbonatite complexes found in the shield area of Ontario.

Acknowledgments

Mr. Arthur Stollery of Morrison Petroleums Limited, formerly Consolidated Morrison Explorations Limited, granted permission to the author to sample drill core from the Argor complex in 1980. Mr. Archie Michell of Moosonee assisted the author and Mr. Lorne Luhta, Resident Geologist, Ministry of Natural Resources, Timmins, assisted with the sampling. In 1988 Mr. Howard Stockford, vice president Aur Resources Incorporated, provided additional information for this report. Statistical compositions of lithologic units were recalculated in 1988 by Mr. A. Lisowyk, Ontario Geological Survey.

Location and Access

The Argor Carbonatite Complex (Figure 1) is located 40 km south of Moosonee, Ontario. Access to the complex is by helicopter during the summer or by winter road and fixed wing aircraft in the winter. The complex is located at approximately 50°53' N Latitude and 80°36' W Longitude.

Physiography

The area has low relief and is mainly covered by marshy ground. South Bluff Creek crosses the area of the intrusion.

Laboratory Techniques

Sampling of the Argor Carbonatite Complex drill core was restricted to homogeneous sections of core from five drill holes. The author sampled holes 2, 8, AB3, 137 and 147. Holes 2 and 8 give nearly complete cross–sections of the complex. The locations of the drill holes are shown on Figures 3–5 (Chart A, back pocket). A portion of each core chip was submitted for complete rock analysis, and a thin section was prepared from the remainder. This left a very small chip for future reference. The core had been split twice, prior to sampling, leaving little for the present study. The samples examined were from the remaining core.

Previous Work

Stockford (1972) published a good description of both the history of discovery of the carbonatite and its geology. Brief mention of the carbonatite complex was

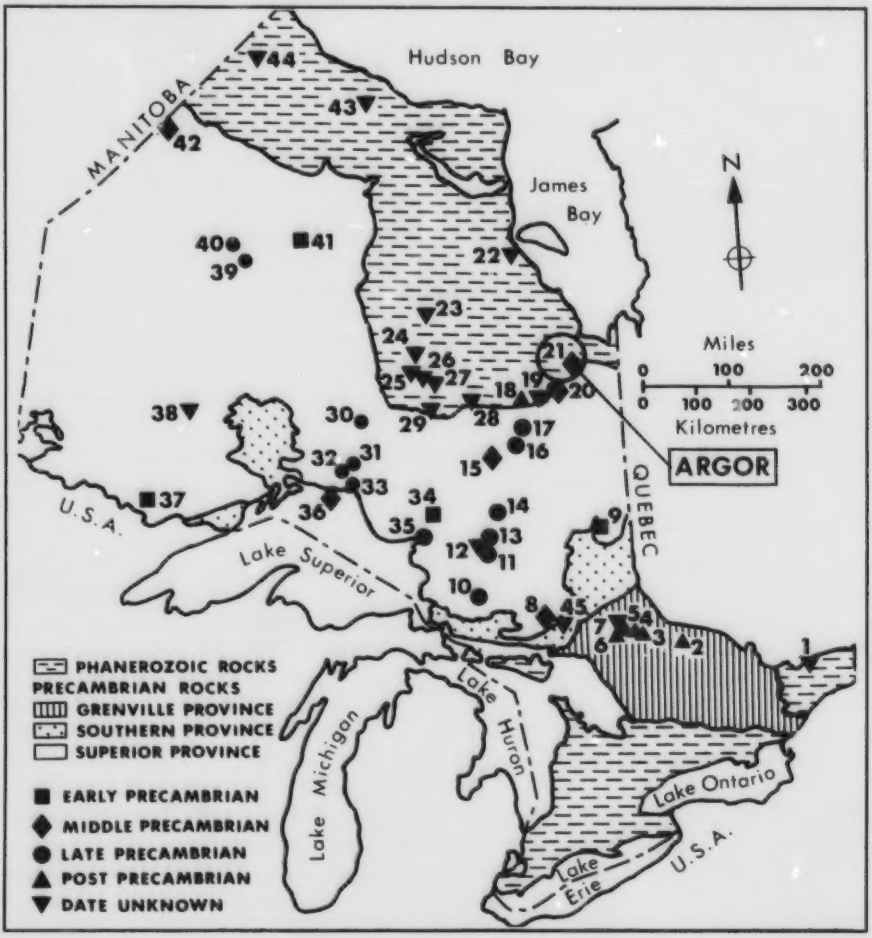

Figure 1. *Key map showing location of carbonatite - alkalic rock complexes in Ontario.*

1. *Eastview*
2. *Brent*
3. *Callander B.*
4. *Manitou Is.*
5. *Burritt Is.*
6. *Iron Is.*
7. *Lavergne*
8. *Spanish R.*
9. *Otto Stock*
10. *Seabrook L.*
11. *Lackner L.*
12. *Borden Tp.*
13. *Nemegosenda L.*
14. *Shenango Tp.*
15. *Cargill Tp.*
16. *Teetzel Tp.*
17. *Clay-Howells*
18. *Hecla-Kilmer*
19. *Valentine Tp.*
20. *Goldray*
21. **Argor**
22. *Lawashi R.*
23. *Poplar R.*
24. *Albany Forks*
25. *L. Drowning R.*
26. *Kingfisher R. West*
27. *Kingfisher R. East*
28. *Martison L.*
29. *Nagagami R.*
30. *Chipman L. (dikes)*
31. *Killala L.*
32. *Prairie L.*
33. *Port Coldwell*
34. *Herman L.*
35. *Firesand R.*
36. *Slate Is.*
37. *Poohbah L.*
38. *Sturgeon Narrows & Squaw L.*
39. *Schryburt L.*
40. *Big Beaver House*
41. *Wapikopa L.*
42. *"Carb" L.*
43. *Gooseberry Br.*
44. *Niskibi L.*
45. *Nemag L. & Lusk L.*

made by Bennett *et al.* (1967). The author has made no attempt to duplicate the work of Stockford (1972). The reader should refer to Stockford (1972) for detailed interpretation of lithologic distribution within the complex.

Twyman (1983) examined specimens from drill holes 3, 4 and 8. The conclusions resulting from Twyman's work were incorporated in this study in 1988, but the microprobe data was too voluminous to include.

Nomenclature

In describing the lithology of the Argor complex the author has used only two rock names to describe the carbonatite rocks: sovite and silicocarbonatite.

Sovite. A carbonatite rock containing 50 percent or more calcite. Various mineralogical modifiers are used to classify the sovite.

Silicocarbonatite. A carbonatite rock containing 50 percent or more oxide and silicate minerals. Where the silicate mineralogy exceeds 90 percent, various other rock names are applied; i.e., ijolite, biotitite, pyroxenite, etc.

The definitions of sovite and silicocarbonatite are modified from Heinrich (1966, p.12). The author has found Heinrich's subdivision of the carbonate–rich carbonatitic rocks generally suitable for field use when modified to a two–fold subdivision at about 50 percent oxide and silicate mineral contents. The two–fold subdivision is more convenient than the four–fold subdivision of Heinrich (1966, p.12) because carbonatites are extremely variable in mineral content over distances of less than a few centimetres. It is difficult to rigorously classify such heterogeneous rocks and they are not mappable at any convenient map scale.

General Geology

The Argor Carbonatite Complex (Table 1, Figure 2 and Figures 3, 4 and 5, Chart A, back pocket) lies in the northern portion of the Kapuskasing Subprovince of the Superior Province. Rocks of this subprovince are characterized by granulite facies rank gneissic rocks and a pervasive north– to northeast–trending fault pattern (Bennett *et al.* 1967).

The carbonatite complex is overlain by approximately 9 m of overburden and 21 m of Lower Devonian rocks (Stockford 1972).

EARLY PRECAMBRIAN (ARCHEAN)

Gneiss

In proximity to the carbonatite complex, Stockford (1972) reported the presence of garnet–hornblende–feldspar gneiss and augen gneiss. The gneisses contain up to 20% quartz, up to 50% plagioclase, 10–15% biotite, 10–20% hornblende, 5% sericite and 5% carbonate (Stockford 1970). Stockford observed that nepheline–bearing rocks and evidence of fenitization are absent. The reported presence of carbonate and possibly sericite in the gneisses suggests some weakly developed metasomatic activity.

Twyman (1983, p.86) reported the presence of fine to medium grained, light grey syenitic rocks with a phaneritic to porphyritic–phaneritic texture. The feldspars are microcline perthite or orthoclase and albite. Calcite occurs interstitially to the feldspars. The mafic minerals reported by Twyman include biotite, pyroxene (salite to sodic salite), and local arfvedsonite. The relationship of the

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR THE ARGOR CARBONATITE COMPLEX.

CENOZOIC	
Recent and Pleistocene	**Swamp and stream deposits; glacial deposits.**
	Unconformity
PALEOZOIC	
Lower Devonian	**Sedimentary rocks.**
	Unconformity
MIDDLE PRECAMBRIAN (PROTEROZOIC)	
Argor Carbonatite Complex	**Sovite; silicocarbonatite.**
	Intrusive Contact
	Pyroxenite–hornblendite.
	Intrusive Contact
EARLY PRECAMBRIAN (ARCHEAN)	**Granitic gneiss; gabbro dikes.**

syenite to the carbonatite is unknown, but Twyman (1983, p.86) considered it to be older than the complex.

Gabbro Dikes

Stockford (1972) reported that gabbroic dikes cutting the gneisses east of the carbonatite complex appear to have been crushed and metamorphosed along with the gneisses. He reported that the dikes consist of plagioclase, feldspar, hornblende, augite and garnet, with accessory apatite, sphene, quartz, chlorite, calcite, pyrite and magnetite. Stockford (1970) reported that the mode of the gabbro dikes is 30–35% plagioclase, 30–40% hornblende, 10–15% augite and up to 25% garnet. A lamprophyre dike was reported in drill core by Stockford (1972) but he also stated that lamprophyres are uncommon in the area.

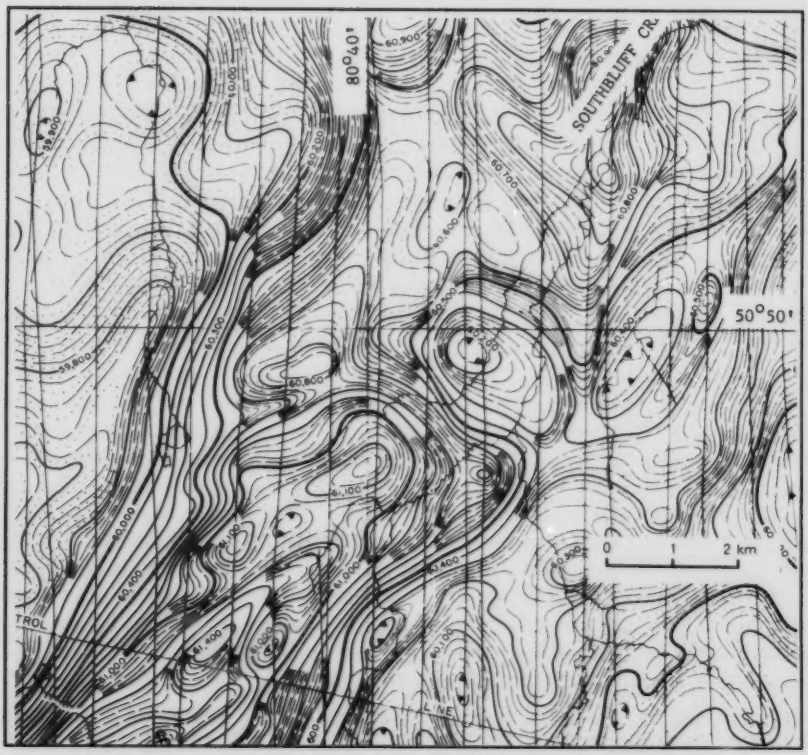

Figure 2. *Aeromagnetic map of the Argor Carbonatite Complex (from Aeromagnetic Map 2345, ODM-GSC 1964).*

MIDDLE PRECAMBRIAN (PROTEROZOIC)

ARGOR CARBONATITE COMPLEX

Pyroxenite–Hornblendite

This phase of the Argor Carbonatite Complex is not well represented in the drill core examined. Hornblende is dominant over clinopyroxene and the pyroxenite and hornblendite appear to grade into each other. While some hornblende is undoubtedly primary, other hornblende clearly formed as a replacement of the clinopyroxene. The pyroxenite and hornblendite are likely part of the same lithologic unit and part of the same magmatic phase. Because of the intimate relationship between the two rock types, they are discussed as one unit. Stockford (1972) described the unit as pyroxenite and he also interpreted the hornblendite to have formed by alteration of the pyroxene. Pyroxenite–hornblendite drill core is black to dark green in colour.

In thin section the rock is fine to coarse grained, massive, inequigranular–seriate, allotriomorphic, with straight to curved grain boundaries. Several specimens have a weakly developed granoblastic texture and several appear to have been weakly deformed.

The mode is estimated to be 5–70% clinopyroxene, 5–98% hornblende, trace to 50% opaques, 0–25% apatite, 0–5% biotite–phlogopite and 0–20% carbonate. Stockford (1972) reported sphene, pyrite, pyrrhotite and zircon as accessory phases.

Clinopyroxene occurs as anhedral, colourless, interlocking grains. It may also be turbid or cloudy and have a brown colour. The pyroxene commonly encloses apatite grains and is observed to have altered to biotite–phlogopite and amphibole. Rarely, pyroxene encloses an opaque grain, rounded blebs of carbonate, or biotite–phlogopite. The alteration to amphibole is common along grain margins but may also occur as patches throughout the grain. The prismatic amphibole cleavage is oriented in the same direction as the prismatic pyroxene cleavage. Allen (1972) presented a few microprobe analyses of the pyroxenes and amphiboles from the pyroxenite unit (Table 2), and a few whole–rock analyses (Table 3).

Amphibole is anhedral, sometimes ragged in appearance and pleochroic in brown and rarely green–brown. It occurs in stubby grains that contrast with the acicular amphibole crystals found in the carbonate–rich portions of the complex. The amphibole grains are interlocked and in some instances have clearly replaced clinopyroxene. The mineral encloses opaques, apatite, and biotite–phlogopite. One sample displays kink–banding of an amphibole grain indicating mild deformation of the specimen. Narrow rims of green–brown amphibole occur as reaction rims between grains of magnetite and clinopyroxene. These amphibole rims were noted in only one sample, but closer study of samples from the complex may indicate it to be more common. The amphibole was likely both a primary crystallization phase and a product of alteration.

Biotite–phlogopite occurs in minor amounts as anhedral to subhedral grains. It forms small tabular grains between amphibole and pyroxene grains and replaces both pyroxene and amphibole. The mineral, in some samples, displays a bent (001) cleavage and encloses small opaque grains and small grains of apatite. One specimen containing minor biotite–phlogopite displays a grain with rounded blebs of enclosed carbonate. The bending of cleavage indicates the rock has undergone mild deformation. Minor biotite–phlogopite in one specimen occupies

TABLE 2. MICROPROBE ANALYSES OF SELECTED PYROXENES AND AMPHIBOLES FROM THE ARGOR CARBONATITE COMPLEX (FROM ALLEN 1972).

	1	2	3	4	5	6
SiO_2	53.26	48.96	41.37	47.74	47.37	39.93
Al_2O_3	0.66	4.81	12.81	6.03	6.02	13.35
TiO_2	0.05	1.38	1.24	2.29	2.73	2.94
FeO*	6.68	6.39	13.68	9.06	7.66	12.78
MnO	0.14	0.10	0.11	0.12	0.12	0.11
MgO	14.25	13.19	12.63	11.42	12.08	12.74
CaO	23.83	22.79	12.11	23.16	23.32	12.14
Na_2O	0.49	0.73	2.60	0.93	0.76	2.90
K_2O	0.01	0.04	1.11	0.01	0.01	1.26
Sum	99.37	98.39	97.66	100.77	100.77	98.15

* total Fe as FeO

1) Clinopyroxene core — Argor 7-265 hornblende pyroxenite
2) Clinopyroxene rim — Argor 7-265 hornblende pyroxenite
3) Amphibole — Argor 7-265 hornblende pyroxenite
4) Clinopyroxene core — Argor 7-660 hornblende titanpyroxenite
5) Clinopyroxene rim — Argor 7-660 hornblende titanpyroxenite
6) Amphibole — Argor 7-660 hornblende titanpyroxenite

fractures in amphibole and a rare grain is completely enclosed in amphibole. The mineral relations suggest that the dominant order of alteration is biotite–phlogopite after amphibole, amphibole after clinopyroxene, and that some of the enclosed opaques (magnetite) in biotite–phlogopite may also be a product of this progressive alteration.

The opaques encountered in this study are assumed to be magnetite. Sulphides were not seen in any of the specimens. The opaques are anhedral, disseminated and occur most commonly in an intergranular setting. Opaques also occur as inclusions in clinopyroxene, amphibole and biotite–phlogopite. The opaques have been observed to enclose small grains of apatite, round blebs of carbonate, and small grains of amphibole.

Apatite is present as anhedral, round grains. Apatite has a granoblastic texture in those rocks with high apatite content. The apatite content approaches 25 volume percent in some rocks. For this reason, it must be considered that the pyroxenite–hornblendite rock is at least in part cumulate in origin.

Carbonate occurs as anhedral interstitial grains.

Twyman (1983, p.85) presented whole rock chemical analyses of the pyroxene and hornblende rocks. He described the pyroxene and hornblende rocks as intercalated and the minerals as cumulate.

Silicocarbonatite

The limited number of silicocarbonatite specimens examined appear to be possible cumulate phases of the carbonatite magma but the fact that some may be reaction products between sovite and other rocks cannot be totally discounted. Drill core representative of this lithology is grey in colour or mottled grey and black.

Samples from the western side of the complex were described by Twyman (1983, p.87) as hybrid rocks with mylonitic fabric and are likely silicocarbonatite. Twyman investigated the possibility of a genetic link between carbonate and sili-

TABLE 3. CHEMICAL ANALYSES, CIPW NORMS, AND MODES OF ROCKS FROM THE ARGOR CARBONATITE COMPLEX (FROM ALLEN 1972).

	Chemical Analyses		
	1	2	3
SiO_2	42.1	36.2	35.8
Al_2O_3	6.5	7.9	10.8
TiO_2	4.0	6.7	3.7
Fe_2O_3	3.7	6.5	4.1
FeO	8.7	9.9	10.6
MnO	0.15	0.22	0.19
MgO	11.8	9.2	11.2
CaO	18.4	16.8	13.9
Na_2O	1.1	1.6	2.8
K_2O	0.40	1.1	1.6
P_2O_5	0.061	1.4	1.3
CO_2	1.7	1.8	2.3
H_2O+	1.1	0.92	2.0
Sum	99.1	100.24	100.29

Samples dried at 105°C for one hour.
Analyst A.G. Loomis.

	Modes		
	1	2	3
Clinopx	51.8	53.0	-
Amph	45.3	15.4	82.5
Biotite	0.4	-	8.1
Sphene	1.5	1.8	1.6
Magnetite	0.2	17.3	3.3
Calcite	0.6	1.2	3.1
Apatite	-	11.2	1.4

		CIPW Norms		
		1	2	3
	Or	2.34	6.34	-
	Ab	2.02	-	-
	Ne	3.93	7.33	12.84
	Lc	-	0.13	7.41
	An	11.65	11.12	12.15
	Wo	28.75	21.56	12.91
Di	En	21.04	17.35	8.68
	Fs	4.74	1.64	3.23
	Fo	5.76	3.83	13.37
Ol	Fa	1.43	0.40	5.48
	Cs	-	-	0.86
	Mt	5.38	9.44	5.96
	Il	7.62	12.75	7.04
	Cc	3.86	4.09	5.23
	Ap	0.13	3.31	3.09
	Rest	1.10	0.92	2.00
	Sum	99.57	100.21	100.25

1) Argor 7-265 hornblende pyroxenite
2) Argor 7-506 magnetite hornblende pyroxenite
3) Argor 101-660 biotite hornblende

cate magmas. On the basis of observed mineral disequilibrium, Twyman concluded the the silicocarbonatite rocks examined by him were the result of assimilation or reaction of carbonatite magma with the enclosing rocks. Microprobe analyses of biotite indicated Al content intermediate between silicate and carbonatite rocks; microprobe analyses of amphibole indicated high Fe content which would have resulted from reaction with a carbonatite magma.

In thin section, silicocarbonatite is fine to medium grained, massive, equigranular to inequigranular–seriate, allotriomorphic with curved to straight grain boundaries. Two specimens are weakly protoclastic. The mode is estimated to be 45–70% biotite–phlogopite, 10–50% carbonate, trace to 5% opaques, 0–10% amphibole, and 0–10% apatite. Traces of sphene occur in several samples.

Biotite–phlogopite occurs as anhedral to subhedral tabular grains. The biotite–phlogopite contains small, anhedral, opaque grains and small rounded blebs of carbonate. Kinking and bending of the (001) cleavage of biotite–phlogopite is common in this rock unit, suggestive of mild to moderate deformation.

Carbonate forms a mosaic of interlocking anhedral grains. One specimen displays carbonate rhombs with bent rhombohedral twin planes and the carbonate grain margins consist of finer–grained carbonate with serrate to lobate grain margins. The carbonate locally displays evidence of deformation and recrystallization. Several discrete euhedral rhombs of carbonate within larger carbonate grains are present in one specimen.

The opaque is likely magnetite. It is anhedral and disseminated. It occurs as intergranular grains, and as small opaque grains enclosed in biotite–phlogopite.

Amphibole is anhedral to subhedral and in places displays ragged edges; locally, it may have undergone some minor replacement by biotite–phlogopite. The amphibole is pleochroic in green to pale green and the crystals are commonly more stubby than those observed in the sovite, but more prismatic than those observed in the pyroxenite–hornblendite. The amphibole locally occurs as twinned crystals and contains rounded blebs of carbonate.

Apatite is minor in this phase and occurs as round to round–elongate anhedral grains.

Trace amounts of sphene are present as anhedral birefringent grains which may occur in clusters of several grains.

Sovite and Minor Rauhaugite

Sovite contains in excess of 50% carbonate. The vast majority of the diamond drilling completed on this complex intersected this lithology since it is host to the niobium mineralization. Rocks of this grouping are grey to white in colour. No attempt was made to estimate the dolomite–calcite ratios in these rocks.

Twyman (1983, p.80–81) reported dolomite (rauhaugite) interstitial to calcite (sovite), implying that both carbonates crystallized simultaneously or that dolomite formed somewhat later. Two types of dolomite were reported by Twyman (1983, p.83–84): (1) a lineated variety is composed of clear, anhedral to subhedral, elongated, interlocking tabular crystals; and (2) a fine grained recrystallized variety with irregular grain boundaries. The lineated variety is interlayered with the sovite and the fine–grained variety occurs along intrusive contacts.

Microprobe analyses of carbonate, presented by Twyman (1983, p.123,135), indicate that dolomite at the Argor complex has an Mn enrichment trend while dolomite at the Cargill complex displays a constant Mn content. At both complexes the carbonate contains minor Mg, Fe, Mn and Sr, but the Argor rocks are richer in Fe. Twyman reported that the Fe enrichment trends in dolomite are compatible with chemical variations in associated amphiboles and biotites.

The minor element trends in dolomite within sovites and rauhaugites are similar, indicating that the sovites and rauhaugites formed at the same time (Twyman 1983, p.127).

Stockford (1972), who had the complete core available for examination, subdivided rocks in this group into five subunits. From the core now remaining, the author concentrated core sampling on holes 2 and 8, which cross–sectioned the carbonate–rich portion of the intrusion. On the basis of 83 thin sections of this

lithologic unit, the author would consider Stockford's five units to be essentially the same rock type for the purposes of this study, even though there is substantial variation in relative accessory mineral content between samples. The same minerals appear commonly throughout the sovite phase of the complex. Stockford (Aur Resources Limited, personal communication, 1988) indicated that the original subdivisions of the carbonatite were based on texture, colour, and calcite–dolomite ratios which at the time of the original work were easy to observe. Stockford's (1972) efforts were directed to close identification of the pyrochlore–bearing carbonatite. While the pyrochlore is the essential economic mineral, it is nonetheless a minor accessory phase within the rock. Stockford (1972) places the pyrochlore content at 1.0% for the potentially economic portion of the carbonatite. The author concurs with this estimated pyrochlore content. The author has observed up to 5% pyrochlore in two samples, but this is unusually high. In applying modifiers to the sovite, the author dropped any mineral from the sequence of mineralogical modifiers to the term "sovite" that is present in quantities of less than 5%. Since pyrochlore is almost always present in quantities less than 5%, the presence of pyrochlore is not generally noted in naming a sample. The author has described the abundance of some samples containing pyrochlore as "pyrochlore–bearing" to indicate its presence. Texturally or mineralogically there is no difference between sovite with and without pyrochlore.

Twyman (1983, p.78–79) reported the presence of olivine sovite and provided a chemical analysis of this rock type. The olivine sovite occurs only on the western side of the complex, does not occur with dolomite, and has been interpreted to be an early phase of the carbonatite magma. Olivine was not observed in the specimens examined by the author.

In thin section, rocks of this lithology are fine to medium grained, equigranular to inequigranular–seriate, hypidiomorphic with straight to serrate grain boundaries. The mode is estimated to be 0–20% biotite–phlogopite, 0–20% opaques, 0–25% amphibole, 0–20% apatite, 50–98% carbonate, and 0–5% pyrochlore. Trace to minor amounts of clinopyroxene, sphene and zircon are also present. Stockford (1972) reported that pyrrhotite, olivine, and epidote are present in this unit. He reported the presence of pyrrhotite and zircon in quantities up to 3% each. Neither of these minerals occur in such quantities within the specimens examined by the author. Olivine was reported to be rarely present (Stockford 1970) and was discussed at length by Twyman (1983).

Biotite–phlogopite occurs as anhedral to subhedral, tabular grains. The mineral may display kinked or bent (001) cleavage in those samples that also display one or both of the features of recrystallization or deformation of the carbonate. Some biotite– phlogopite grains enclose anhedral to euhedral, commonly acicular amphibole grains, anhedral opaque grains and rounded blebs of carbonate. The mineral rarely encloses a pyrochlore grain. Rounded blebs of carbonate and prismatic or acicular amphibole grains are by far the most abundant inclusion found in the biotite–phlogopite. The biotite–phlogopite displays a slight preference to occur in association with the opaque mineral. Stockford (1972) referred to the mica in his 'pyrochlore–absent amphibole–biotite carbonatite' as biotite, and in the 'pyrochlore carbonatite of the central core' as phlogopite. A microprobe analysis of the mica is given in Table 4.

Twyman (1983, p.81) reported that the Argor biotite is undergoing alteration to hydrobiotite, a mixture of vermiculite and biotite. He interpreted the alteration as hydrothermal in origin, resulting in loss of K, increase in Fe and no change in Al. On the basis of microprobe analyses of the micas, Fe increases and Mg de-

TABLE 4. MICROPROBE ANALYSES OF MINERAL GRAINS FROM THE ARGOR CARBONATITE COMPLEX (ANALYSES BY D. WATKINSON).

	1	2	3
Na_2O	8.55	8.65	0.17
FeO*	13.34	13.47	15.49
SiO_2	53.44	53.94	38.58
K_2O	1.61	1.62	9.38
MgO	15.58	15.87	18.41
MnO	0.10	0.02	0.03
Al_2O_3	0.72	0.79	9.54
CaO	1.51	1.78	0.00
Cr_2O_3	0.02	0.04	0.00
NiO	0.00	0.00	0.15
TiO_2	0.09	0.06	0.54
OH	2.00	2.03	3.85
Total	96.96	98.25	96.15

* Total iron given as FeO.
1. Amphibole, average of three values on edge of grain. Amphibole in carbonatite.
2. Amphibole, center of amphibole grain. Amphibole in carbonatite.
3. Mica grain.

creases with differentiation. The Argor mica was described by Twyman (1983, p.114,115) as tetra–ferriphlogopite which displays a differentiation trend from biotite to annite.

The opaques occur as anhedral to euhedral disseminated grains. The opaque is likely magnetite and is referred to as titaniferous magnetite by Stockford (1972). Some magnetite grains enclose rounded blebs of carbonate and anhedral to euhedral grains of amphibole. More uncommonly, the magnetite encloses anhedral apatite or biotite–phlogopite. One specimen contains several grains of crudely skeletal magnetite. The magnetite displays a slight preference to occur in association with biotite–phlogopite. Rounded blebs of carbonate are common inclusions in the larger magnetite grains and amphibole is the second most common inclusion in magnetite.

The opaques pyrite, ilmenite, pyrrhotite and magnetite were reported to be present; pyrite and ilmenite occur only in arfvedsonite and aegirine carbonatite (Twyman 1983, p.82).

Amphibole is euhedral, acicular to prismatic, twinned, and pleochroic in green to pale green. Without this mineral, the sovite would have an allotriomorphic texture rather than hypidiomorphic texture. The amphibole encloses rounded blebs of carbonate, anhedral to subhedral opaques, and rarely tiny tabular grains of biotite–phlogopite. Amphibole containing tiny inclusions of pyrochlore were observed but this relationship is rare. Under crossed nicols, faint concentric colour mottling of the larger amphibole grains in several specimens implies the possibility that compositional zonation may be present. By far, the most common inclusion in amphibole is rounded blebs of carbonate. Stockford (1972) classified this amphibole as riebeckite. Microprobe analyses of the amphibole are given in Table 4.

The petrologic modelling of the Argor and Cargill carbonatites involves, in part, the study of amphibole chemistry (Twyman 1983). Twyman reported that the amphibole is richterite to arfvedsonite with little zoning. Where zoning is present, the grain rims are Na and Fe rich. The amphibole crystals locally are skele-

tal and contain carbonate inclusions. The amphibole chemistry indicates that dolomite and calcite crystallized at the same time (Twyman 1983, p.103). Twyman reported that the amphibole chemistry in both carbonatite and silicate rocks defines separate trends toward alkali enrichment which discounts the possibility that the carbonatites are residual magmas formed by fractional crystallization of the silicate magma.

Microprobe analyses of amphibole are given by Twyman (1983, p.101). The analyses indicate that there is a dramatic increase in Fe/Mg ratios with differentiation at both the Argor and Cargill carbonatites. The Argor amphiboles display an increase in Al content with constant K, while the Cargill amphiboles contain no Al and the K content increases with differentiation (Twyman 1983, p.146). Twyman observed that Ti increases in amphibole and biotite at Argor, but not at Cargill upon differentiation.

Apatite occurs as anhedral, round to round–elongate grains, commonly of irregular shape. Within several specimens the apatite displays cuspate grain margins, implying some resorption of the apatite. The apatite commonly encloses round blebs of carbonate, and less commonly, anhedral to euhedral grains of amphibole. Several instances of small round grains of pyrochlore enclosed in apatite have been observed. It is uncommon, but opaques enclosed in apatite have also been noted and two occurrences of biotite–phlogopite enclosed in apatite were found. Large apatite grains that are fractured and cemented with carbonate have been observed in several specimens, implying mild deformation of the samples.

Carbonate forms a mosaic of interlocking anhedral grains. The carbonate consists of both dolomite and calcite (Stockford 1972). The present author, however, did not attempt to subdivide the carbonates in this study. Several specimens of carbonatite appeared to consist of a crude eutectic–like intergrowth of two carbonates. These samples appear to have been deformed and recrystallized and are from Stockford's (1972) unit 6. Relatively undeformed carbonates grade into totally deformed and recrystallized carbonates. Deformation is also indicated by bending and kink–bending of biotite–phlogopite and by fracturing of apatite grains and perhaps amphibole.

The undeformed carbonate is medium to coarse grained, equigranular, granoblastic, with curved grain boundaries. Recrystallization started around the edges of large carbonate grains, resulting in a fine–grained carbonate with lobate to serrate grain boundaries. With increasing deformation, the large carbonate grains appear as porphyroclasts set in a fine–grained matrix of carbonate with lobate to serrate grain boundaries. The rhombohedral twin planes of the large carbonate porphyroclasts may display bending due to deformation. The orientation of the porphyroclasts in the matrix gives the impression that the carbonate was crushed and rolled. Under advanced recrystallization, the large porphyroclasts disappear and the carbonate is fine to medium–grained, with lobate to serrate grain boundaries.

Pyrochlore is present as a minor accessory mineral in the carbonatite, but it is the main mineral of economic interest. It occurs as anhedral to sharply euhedral grains that commonly contain rounded, irregular grains of carbonate. The mineral is red–brown to grey in colour. Its high relief and isotropic nature make it relatively easy to distinguish from other minor mineral phases. The mineral often appears crudely zoned from red–brown cores to grey rims, but the reverse zoning pattern has also been observed. The zonation implies compositional variation. One grain possibly contains a small opaque inclusion and one grain contains an

TABLE 5. MICROPROBE MINERAL COMPOSITION OF PYROCHLORE FROM THE ARGOR CARBONATITE COMPLEX (FROM STOCKFORD 1972).

Element	Range (Percent)
Nb_2O_5	57–65
TiO_2	0.8–2.0
FeO	0.0–0.4
Al_2O_3	0.01–4.0
CaO	13.0–16.0
Na_2O	6.0–14.0

inclusion of biotite–phlogopite. In one specimen, the pyrochlore appears to be associated with magnetite. In nearly all cases however, there is no obvious association with the opaques. Several of the specimens richest in pyrochlore contain only trace to minor quantities of opaques.

Twyman (1983, p.141) presented microprobe analyses of Argor pyrochlore which show a general Nb, Ca and Na enrichment and Ta, U and light rare earth elements (LREE) depletion upon differentiation from early olivine sovite to late arfvedsonite carbonatite. The Argor pyrochlore contains less Ti, Ba and LREE than Cargill pyrochlore and both Argor and Cargill early–formed pyrochlores are rich in U and Ta. Differentiation therefore decreases the U and Ta content of pyrochlore. Twyman (1983,p.83) observed alteration of pyrochlore to columbite.

Table 5 gives the microprobe composition of pyrochlore, as reported by Stockford (1972). Stockford (1972) reported that most pyrochlore crystals contain 0.5% Ce_2O_3. U, Th, Zr, Ta, Ba, Eu and Sr were analyzed for but not detected (Stockford 1972). In spite of colour variation in the pyrochlore implying compositional variation, microprobe analyses indicate that the pyrochlore is relatively homogeneous (Stockford 1972).

Sphene occurs as anhedral to subhedral grains and generally there are only several small grains in a given thin section. It usually contains irregular, rounded carbonate inclusions that make it appear similar to pyrochlore. It can be easily distinguished from pyrochlore by its birefringent non–isotropic nature. The mineral occurs in quantities of 1% or less.

Several thin sections contain small, euhedral, square, stubby crystals with pyroxene cleavage. The mineral displays a red–brown alteration along edges and cleavages and is pleochroic from very pale green to colourless. On the basis of sketchy optical data, the author tenuously considers this mineral to be aegirine augite. This mineral always forms less than 1% of a sample.

Aegirine was reported by Twyman (1983, p.82) but only in the eastern part of the Argor complex, where it occurs as euhedral to subhedral crystals. At Argor, the aegirine carbonatite is late in emplacement and aegirine was interpreted to be partially replaced by arfvedsonite (Twyman 1983, p.106). A microprobe analysis of the aegirine was presented by Twyman (1983, p.101).

Olivine occurs in the Argor carbonatite (Twyman 1983, p.82) as subhedral to euhedral crystals up to 5 mm in diameter, which co–exist with early formed Mg–rich phases. The olivine is unzoned and has a forsterite content of 68–69%. Its absence in more evolved rocks was interpreted by Twyman to be the result of peritectic reaction with the carbonatite magma as it evolved. Olivine does not co–exist with dolomite, but zircon does (Twyman 1983, p.135–136). The olivines at Argor and Cargill are MgO–rich and NiO–poor with moderate to high MnO contents. The Cargill olivines are richer in MgO than the Argor olivines.

PETROLOGY

Stockford (1972), on the basis of textural evidence of deformation, considered that the Argor Carbonatite Complex was emplaced as a series of crystal mushes at a temperature of at least 850°C. Carbonatite magmas are of low density and low viscosity (Wyllie and Tuttle 1960; Nesbitt and Kelly 1977) such that crystals would rapidly separate from the host melt during crystal fractionation. Therefore, in the author's opinion, the carbonatite was not likely emplaced as a crystal mush but was a cumulate phase of a carbonatite magma. In addition, all the major components, carbonate, amphibole, biotite–phlogopite, apatite and magnetite contain inclusions of the other major components, implying nearly simultaneous crystallization of mineral phases in the crystallizing carbonatite magma. The Argor Carbonatite Complex is one of several Proterozoic carbonatite intrusions in Ontario. If these complexes have one thing in common, it is evidence of deformation and recrystallization. The only exception to this rule would possibly be the "Carb" Lake Carbonatite Complex, located in the extreme northwest corner of the Province. The deformation textures are therefore interpreted by the author as not being primary in nature, but secondary, having been formed by dynamo–thermal metamorphism along fault zones after emplacement.

A carbonatite is an alkali–rich, volatile–rich magma which loses its volatiles and alkalies during crystallization and fenitization or phlogopitization of the enclosing wall rocks (Gittins *et al.* 1975). Therefore, carbonatite rock is not compositionally a melt equivalent, but a residuum left after volatile and alkali loss (Gittins *et al.* 1975). The chemical compositions of carbonatites (*see* Appendix A) can therefore not be used to postulate melt compositions.

In addition, the carbonatite magma, before volatile and alkali loss, was likely one liquid of an immiscible liquid–pair (Le Bas and Handley 1979; Hamilton *et al.* 1979; Freestone and Hamilton 1980). These two immiscible liquids were likely derived by immiscible splitting of a carbonated alkali–rich silicate magma parent. The complex magmatic history of carbonatites precludes present rock compositions from being considered as original melt compositions.

The relationship of the carbonatite to the pyroxenite is uncertain. The carbonatite intrudes the pyroxenite and the pyroxenite is unusual in that ijolite was observed by the author to be present in most carbonatite complexes of Ontario, suggesting ijolite is more likely representative of a comagmatic phase than pyroxenite. The possibility should be entertained that the pyroxenite was emplaced during an earlier period of magmatism along the fault zone hosting the carbonatite. This fault zone would be a plane of weakness along which the younger carbonatite magma was injected into the pyroxenite. The pyroxenite and carbonatite may therefore not be petrogenetically related. In opposition to this proposal, two other carbonatites within the region, of similar age, display a carbonatite–pyroxenite relationship, implying that there is a cogenetic relationship between the two rock types.

A detailed experimental and microprobe study of the Argor and Cargill carbonatites was completed by Twyman (1983) for the purpose of petrogenetic modeling. He found that sovite is not a magma composition but a crystal cumulate. Twyman (1983, p.41) recognized a continuum between carbonatite magma and hydrothermal systems.

The Argor carbonatite has been interpreted by Twyman (1983, p.150) as representing four magma intrusions; the observed cryptic variation of the Mg/Fe ratios which decrease toward the centre of the intrusions represent *in situ* differ-

entiation from chamber walls inward. Variation in crystallization sequences is due to variation in oxygen fugacity. The lower Mg/Fe ratios along with higher Ti and Mn at Argor relative to Cargill is a function of less magnetite and ilmenite crystallization at Argor (Twyman 1983, p.160–161).

Twyman (1983, p.183) estimated that the Argor and Cargill magmas crystallized at 2 to 5 kbars with crystallization temperatures between 1100 and 500°C. Using ilmenite and magnetite pairs in arfvedsonite carbonatite, Twyman determined a maximum carbonatite crystallization temperature of 512°C for Argor, however, he concluded that due to mineral disequilibrium of the carbonatite mineralogy, the crystallization temperature could not really be established.

From a study of olivine chemistry, Twyman (1983, p.200) proposed that the olivine sovite magma originated from mafic source material via partial melting and liquid immiscibility. Twyman (1983, p.209–210) favours immiscibility in carbonatite magma formation since the LREE content requires less than 1% partial melting. This must occur in the upper mantle since 27 kbar pressure is required to keep CO_2 in the melt and permit alkali–rich melt to exist along with orthopyroxene. Immiscibility would occur as pressure falls below 27 kbar. The separation is early since distinctly different amphibole trends exist in carbonatite and silicate melts.

Twyman (1983, p.2–4) proposed that the parent carbonatite magma was olivine sovite with 8% alkalies formed by liquid immiscibility from a mafic alkalic silicate parent at 1100 to 1200°C and 27 kbars pressure. An alkali–rich residual carbonatite magma develops as a differentiate from the olivine sovite magma and, with up to 85% crystallization, the alkali content may approach 37% (Twyman 1983, p.214).

Twyman (1983, p.224) suggested that whole rock LREE concentrations may represent magmatic trends since these elements are not incompatible elements in a carbontatitic magma.

GEOCHRONOLOGY

The Argor Carbonatite Complex has been dated at 1655 Ma by K–Ar isotopic techniques on biotite (Gittins *et al.* 1967). Most Middle Precambrian (Proterozoic) complexes have isotopic ages of 1800 Ma. Considering this fact, along with the knowledge that the complex has undergone local deformation and recrystallization with the possible attendant loss of argon, additional isotopic age studies may be warranted.

METAMORPHISM

The complex displays all variations, from a well–developed granoblastic texture with curved grain boundaries typical of carbonatite rocks, to one that is very fine– to fine–grained recrystallized with serrate to lobate grain boundaries. In examining thin sections of the complex, relatively undeformed carbonate alternates with deformed carbonate, suggesting deformation and recrystallization has occurred in zones within the carbonatite, likely due to dynamo–thermal metamorphism associated with fault movement.

Stockford (1972) reported the absence of fenitization presumably on the basis of the absence of green to blue–green soda–iron amphiboles and pyroxenes within the enclosing gneissic wall rocks. The presence of carbonate, the alteration of pyroxene to amphibole and amphibole to biotite–phlogopite in the pyroxenite

rocks, is interpreted by the author to represent metasomatism of the pyroxenite by alkali–rich, aqueous, carbonate–rich fluids similar, if not identical, to a fenitizing liquid. The pyroxenite is however an early crystallizing phase of the carbonatite complex and not part of the much older wall rock assemblage. This process of phlogopitization was considered to be a fenitizing process by Gittins *et al.* (1975). The alteration is related to carbonatite emplacement. A carbonatite magma is originally considered to be an aqueous alkali–rich carbonate magma which loses alkalies and volatiles upon emplacement and crystallization. The loss of alkalies and volatiles gives rise to the metasomatizing (fenitizing) fluid leaving a carbonate residuum (Gittins *et al.* 1975). A zone of phlogopitization that forms by alkali and volatile loss from the original carbonatite magma and reaction with the enclosing pyroxenite, could be expected to occur in the area of contact between the older pyroxenite of the rim and the younger carbonatite–rich rocks of the core of the complex.

Stockford (1972) reported the presence of sodic amphiboles in a mylonitic gneiss at the pyroxenite–gneiss contact on the east side of the complex. These sodic amphiboles may be indicative of more typical fenitization developed within restricted zones of greater permeability. Carbonate along fractures in the gneisses, was reported by Stockford (1972) to occur for distances of up to a few hundred metres from the carbonatite contact. This is considered by the author to be due to either the effect of a fenitizing liquid in a distal setting, or to a fenitizing fluid at relatively low temperatures, in essence, under hydrothermal conditions.

STRUCTURAL GEOLOGY

REGIONAL SETTING

The Argor Carbonatite Complex is located in the north portion of the Kapuskasing Subprovince of the Superior Province of the Canadian Shield. This subprovince is characterized geophysically by a northeast–trending zone of gravity highs and pronounced linear aeromagnetic trends (Innes 1960; ODM–GSC 1970). This anomalous gravity zone has been interpreted to be due to an upwarp in the Conrad discontinuity caused by major regional faulting and the formation of a complex horst structure (Wilson and Brisbin 1965; Bennett *et al.* 1967). This upthrown block is characterized by rocks that have locally reached the granulite facies rank of metamorphism (Bennett *et al.* 1967; Thurston *et al.* 1977).

The Kapuskasing Subprovince (Kapuskasing Structural Zone) has been interpreted by Percival and Card (1983) to be an oblique section through 20 km of the Archean crust. The structural zone has been uplifted along a northeast–striking, northwest–dipping thrust fault. Along the east side of the structural zone, high–grade rocks are thrust against low–grade rocks. To the west, the high–grade rocks grade into low–grade rocks over a distance exceeding 100 km. Thrusting has exposed the Conrad Discontinuity within the Kapuskasing Structural Zone (Percival 1986).

LOCAL STRUCTURES

Stockford (1972, Figure 4) indicated that the Argor Carbonatite Complex was emplaced into a series of northeast– and north–trending faults. The enclosing gneisses are described as mylonitic or augen gneisses and minor faulting along the east contact has been reported (Stockford 1972). Stockford (1972) indicated the Argor Carbonatite Complex to be a dike–like body with a long axis striking north.

The body occurs in a north–trending fault zone north of the junction of a northeast– and a north–trending zone of faulting. The intrusion has not been totally delineated in strike length. It is known to be at least 1440 m long and remains open to the north. The complex appears to have a minimum width of approximately 360 m in the area of pyrochlore mineralization. Pyrochlore mineralization has been identified to a maximum depth of 270 m. The zone of pyrochlore mineralization occurs in the southern portion of the complex and in plan view it covers a maximum area approximately 900 m long and 180 m wide.

Whether the complex was originally emplaced as a dike–like body or as a more circular stock typical of most carbonatite intrusions, and then subjected to faulting and deformation to produce its present shape, cannot be determined. The author suspects the body may have originally been more elliptical in shape with its long axis parallel to the faults that controlled its emplacement. This elliptical shape has been modified to a dike–like plan view by subsequent fault movements.

Over the core lengths examined, the carbonatite displays a mineralogical variation which imparts a banding to the rock. In addition, the elongate minerals, amphibole and apatite, have their long axes subparallel to each other and define a lineation in the plane of the banding. The attitude of the banding is steep to vertical and contacts appear conformable (Stockford 1972).

Stockford (1972) reported a zone of crushed dolomitic carbonatite (his Zone 8) in the approximate center of the carbonate phase of the complex. This zone of crushed dolomitic carbonate consists of crushed and recrystallized carbonate in a turbid groundmass of carbonate, chlorite, and hematite (Stockford 1972). He reported that accessory apatite, feldspar, pyrite and pyrochlore–columbite are also present. Amphibole crystals within this rock unit are contorted and minor molybdenite has been recognized (Stockford 1972). In thin section, the carbonate from this area displays both unstressed granoblastic and recrystallized deformed textures. The unstressed carbonate is equigranular and has curved grain boundaries. From the unstressed carbonate, the next stage of deformation and recrystallization is indicated by recrystallized fine–grained granoblastic carbonate along the grain boundary edges and weak to moderate bending of the (001) cleavage in biotite–phlogopite. This stage is followed by an inequigranular–seriate, porphyroclastic texture. This porphyroclastic texture is defined by rounded to rolled grains of coarse carbonate set in a matrix of fine–grained recrystallized carbonate with serrate to lobate grain boundaries. The associated biotite–phlogopite displays bending and kink banding of the (001) cleavage. Amphibole and apatite grains are also fractured. Bending of the rhombohedral twin planes of the larger carbonate porphyroblasts is not uncommon. With total to nearly total deformation and recrystallization, the accessory minerals display the above cited evidence for deformation and are set in fine–grained granoblastic carbonate with serrate to lobate grain boundaries. At this stage, the author rarely observed textures suggesting the presence of two carbonates in a eutectic–like intergrowth.

Stockford (1972) has interpreted the deformation textures to be the result of the pulsating emplacement of the carbonatite magma as a crystal mush. The Argor Carbonatite Complex has been emplaced into a fault zone as have nearly all of the other carbonatite complexes of this age group. With the possible exception of the "Carb" Lake Carbonatite Complex, all other Proterozoic complexes are in rocks cut by faults and display evidence of deformation and recrystallization. These other complexes are Spanish River, Cargill, and Goldray. The author considers the deformation–recrystallization textures to be due to dynamo–thermal

metamorphism associated with fault movement subsequent to emplacement and crystallization.

RECOMMENDATIONS FOR FUTURE STUDY

Additional efforts are needed in isotopic age determination using other techniques*. The complex has been deformed and the present determined age is thus likely to be somewhat younger than the true age due to probable argon loss. Stockford (1972) made reference to chemical data on the mineralogy, but this data was unavailable to the present author. Additional microprobe study of the mineralogy of this complex may be warranted. If the complex is exposed in mining operations, additional study of its internal structures is warranted. The petrogenetic relationship between the pyroxenite and carbonatite requires additional study.

GEOPHYSICAL DATA

The Argor Carbonatite Complex was straddled and consequently missed by the north–south, 1–mile spaced flight lines of the Federal–Provincial aeromagnetic surveys of the region (Figure 2). A consortium of companies, Argor Explorations Limited, Consolidated Morrison Explorations Limited, and Goldray Mines Limited, which held three licences of occupation for the area, joined together in completing detailed aeromagnetic and electromagnetic surveys in 1965. The flight lines were flown at a quarter–mile spacing in a northwest–southeast pattern perpendicular to the strike of the Kapuskasing Subprovince.

This airborne survey identified a magnetic anomaly referred to as Alpha–B which was later identified as a pyrochlore–bearing carbonatite by a diamond drill follow–up program.

Subsequent to the airborne survey the companies completed ground magnetic surveys over a 26 km^2 area (Figure 6). The grid lines were at 120–240 m spacing. This work disclosed that the intrusion was not bounded by the isomagnetic contours of the magnetic anomaly and that to the north, the complex extends through areas of low magnetic relief.

**At the time this study was going to press, an approximate Pb–Pb age of 1950 Ma was determined for the Argor Carbonatite Complex by S.T. Kwon (University of California, Santa Barbara, personal communication, 1988).*

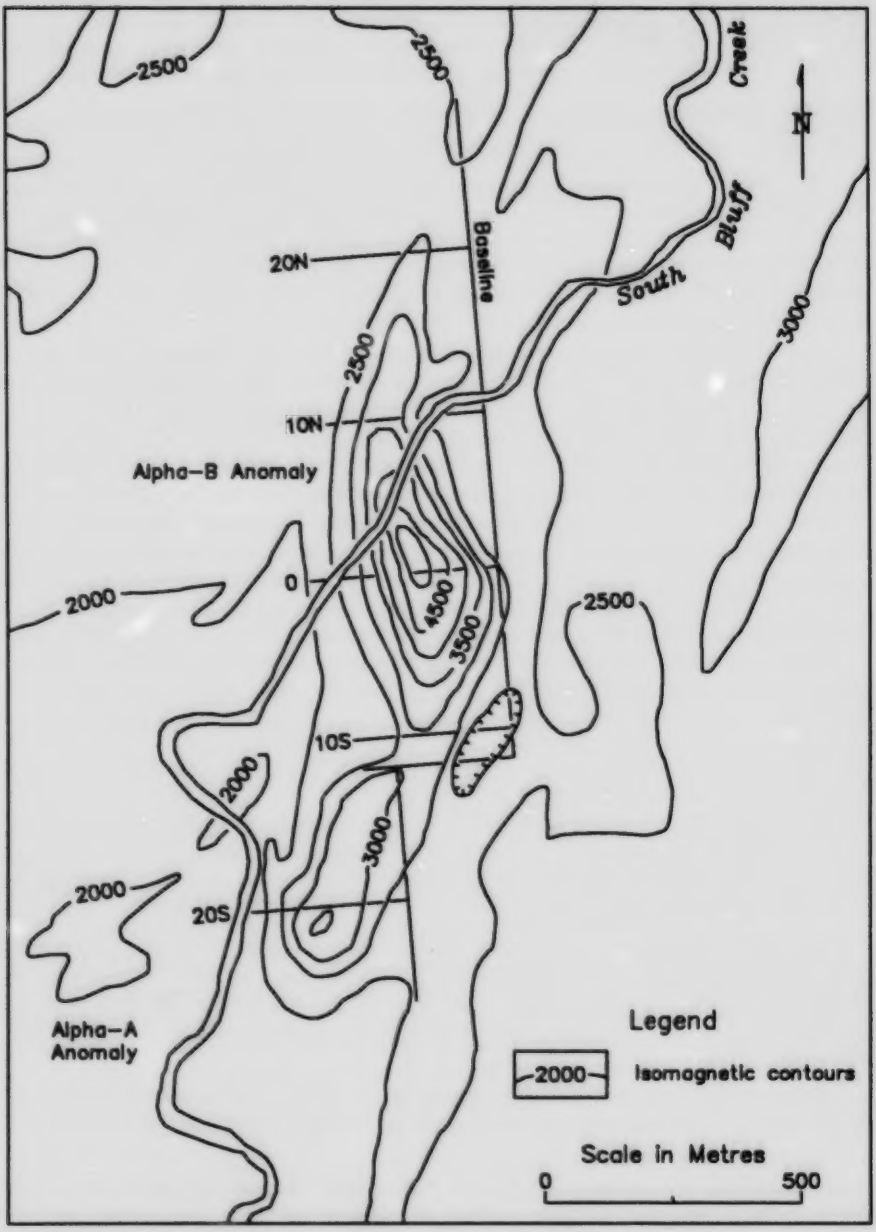

Figure 6. Detailed ground-magnetic survey of the Argor Carbonatite Complex; data compiled from File 83.1-47, Assessment Files Research Office, Ontario Geological Survey, Toronto.

Economic Geology

Carbonatites are noted for anomalous concentrations of the rare earth elements, phosphorus, niobium, uranium, zirconium, and perhaps base metals.

The Argor Carbonatite Complex is known principally as a niobium deposit. The niobium occurs in the mineral pyrochlore and to a much lesser extent in columbite. Stockford (1972) reported, on the basis of microprobe analyses, that the Argor pyrochlore is relatively homogeneous in composition, even though thin section study by both the author and Stockford (1972) suggests zoning of the pyrochlore grains.

The columbite occurs along the eastern side of the complex over a strike length of 120 m in the crushed dolomitic carbonatite. The columbite is totally or partially pseudomorphic after pyrochlore. The columbite may occur in the core of the crystal, on the rim of the crystal, or completely replaces the pyrochlore. Stockford (1972) stated that the columbite is not restricted to any one rock unit, but it does appear to be related to fracturing and hematitic alteration. The author is unaware of the presence of significant columbite in any other Ontario carbonatite but it is a significant ore mineral in the No.1 zone of the St. Honôré carbonatite, Québec (Gagnon 1979). Gagnon (1979) attributed the columbite to metasomatism of pyrochlore, whereby iron has replaced calcium in the pyrochlore. He also reported that yttrium, thorium and uranium addition has occurred concomitant with sodium subtraction. The author has examined the St. Honôré carbonatite and is of the opinion that the ore deposit is a supergene deposit formed by weathering processes that were effective to the present limits of the workings. The possibility should be considered that columbite replacement of pyrochlore may be a supergene phenomena. The association of columbite with deformed and crushed dolomite at Argor suggests a non–magmatic or late–stage hydrothermal origin for the mineral. The author suggests that the columbite is a supergene mineral after pyrochlore, formed in more permeable fault zones cutting the carbonatite. Reddening or oxidation of the core was noted by the author in columbite–bearing sections.

Apatite is an abundant accessory mineral in the Argor Carbonatite Complex and the author is of the impression that modally, the complex contains more accessory apatite in primary carbonatite than most Ontario carbonatites. Apatite (phosphorus) could make a valuable by–product to any mining operation on the complex.

Uranium appears to be largely absent at the Argor Carbonatite Complex as Stockford (1972) reported the carbonatite to be essentially non–radioactive.

Additional testing for zirconium is warranted at the Argor Carbonatite Complex. Stockford (1972) reported the presence of zircon crystals in quantities up to 3.0%. Several assays of samples collected by the author gave high zirconium values (see Appendix A, Table A–3).

Stockford (1972) reported the presence of molybdenite in the crushed dolomitic zone within the center of the carbonate phase of the complex. The author has observed anomalous molybdenum in several Ontario carbonatites and it is also reported in the St. Honôré carbonatite in Québec (Gagnon 1979). Molybdenum is likely only of mineralogical curiosity.

Stockford (1972) reported that pyrite and pyrrhotite are present in quantities up to 2% in the carbonatite and that minor chalcopyrite with pyrite and pyrrhotite

occur in the pyroxenite. The potential presence of disseminated sulphide mineralization of economic interest within the pyroxenite cannot be discounted even though present data are not encouraging.

The carbonatite–pyroxenite contact area should be examined for the presence of vermiculite. This contact area would appear to offer some potential for vermiculite, based on the phlogopitization model of Gittins *et al.* (1975).

Stockford (1972) reached the following conclusions regarding the niobium mineralization within the Argor Carbonatite Complex.

1. Significant pyrochlore mineralization occurs only in sodium– and magnesium–rich phases of the carbonatite. Important accessory minerals that occur in the niobium–enriched carbonatite are phlogopite and amphibole.

   Note: On the basis of thin section study, the author would add apatite to the list of important accessory minerals both within pyrochlore–bearing and non pyrochlore–bearing carbonatite.

2. The best mineralization is in a mixed dolomite–calcite host (Stockford 1972, Unit 6). The pure dolomitic host (Stockford 1972, Unit 5) produces intermediate grades and pure calcite (Stockford 1972, Units 2, 7 and 9) is normally low in grade or barren.

The rare earth element content of the Argor Carbonatite Complex is not outstanding and on the basis of the author's chemical data, the complex is lower in overall rare earth element content than others. Any apatite concentrate from the complex should be checked for its rare earth element content to see if it warrants recovery.

Titaniferous magnetite is a widespread accessory mineral but it is not expected to have great economic value even as a by–product.

The crushed dolomite zone of Stockford (1972) may be the ankerite breccia zone of Twyman (1983). The ankerite breccia was interpreted by Twyman as the result of replacement of sovite by reaction with late non–magmatic hydrothermal fluids. These hydrothermal fluids were rich in Na, Fe and S and may have been derived from the aegirine carbonatite (Twyman 1983, p.90). Since adjacent sovite replaced by dolomite and ankerite preserves the textures within the sovite a replacement origin is indicated (Twyman 1983, p.89).

The breccia is fine to medium grained, light pink in colour with a dusting of opaque minerals (Twyman 1983, p.89). Aegirine may be partly replaced by quartz; apatite occurs as broken grains; pyrochlore is replaced by columbite and clusters of hydrobiotite are present. Twyman reported that the breccia weathers to dolomite and hematite and therefore the ankerite could easily be mistaken for siderite. Twyman reported veins of ankerite, quartz and aegirine cutting richterite sovite in drill hole 3, with the richterite altering to arfvedsonite along vein contacts.

The ankerite breccia and veins are post magmatic and cut the other carbonatitic rock types (Twyman 1983, p.130). Twyman presented a microprobe analysis of the ankerite carbonatite (1983, p.128).

Twyman (1983, p.83) observed that zircon is most abundant in olivine sovite and pyrochlore is rare or absent. The pyrochlore first appears as an accessory phase in the richterite sovite (Twyman 1983, p.83). The observations of Twyman indicate that pyrochlore would be concentrated in late magmatic, more fractionated phases of the carbonatite.

Any discussion of carbonatites lying beneath an unconformity must include some comment on the possibility of residual mineral accumulations on the surface

of the intrusion. A complex as rich in pyrochlore and apatite as Argor could produce a residuum of considerable economic interest. Stockford (1972) reported that the upper surface of the complex has undergone sideritization and that the ferromagnesian minerals have been chloritized. This sideritization or rusty brown colour of the carbonatite is a near surface feature, since siderite is absent in the main carbonatite body (Stockford 1972). In the area of the test shaft, the zone of oxidation and weathering is 3 m thick. The hematization and chloritization of the carbonatite described by Stockford (1972) appears similar to that observed by the author at the St. Honôré carbonatite in Québec. The author observed some reddening of the carbonatite and very local vugs in some very limited sections of the stored drill core from Argor and would expect supergene processes may be more extensive than previously recognized. There is no evidence that supergene processes were anywhere as extensive at Argor as at St. Honôré. High–grade chlorite–carbonate breccia at the surface, pervasive hematization and veining by coarse carbonate, large clay–filled vugs, and high–grade quartz–feldspar graded bedded material in the deepest workings at St. Honôré observed by the author in 1980, were all interpreted by the author as supergene in origin. In 1983 Thiviege *et al.* published a description of the St. Honôré deposits describing the deep weathering and karst–like development of these deposits. Some of the features originally interpreted by the present author as the product of supergene processes have been interpreted as the result of low temperature hydrothermal alteration before karst development took place (Thiviege *et al.* 1983). The columbite at St. Honôré and Argor may be supergene rather than hydrothermal in origin but additional work is required to prove this conjecture. On the basis of personal observation and the data cited by Gagnon (1979), the St. Honôré carbonatite is a carbonatite grading 0.3 to 0.4% Nb_2O_5 that has been upgraded by supergene processes to ore grade material of 0.7% Nb_2O_5. The Argor drill core appears to be generally fresh unweathered carbonatite and thus the grades cited are likely representative of primary carbonatite. Stockford (1972) did not report evidence of supergene processes in the test shaft; however, the presence of chlorite and hematite in the crushed dolomitic carbonate pyrochlore–columbite–bearing zone number 8 (Stockford, 1972) warrants examination as to whether it was upgraded by supergene processes. Stockford (personal communication, 1988) indicated that this zone may have been upgraded but it is not as rich as his unit 6 and not nearly as clean metallurgically.

Considering the volume of drilling already completed on the complex, the location of residuum deposits of economic interest appears unlikely. Stockford (personal communication, 1988) indicated that this statement is likely to be true, however only 3 of the 200 series holes tested the overburden above the pyrochlore–bearing unit 6. Stockford indicated that the soft material encountered above the carbonatite in the other diamond drill holes was not recovered.

PROPERTY DESCRIPTION

ARGOR EXPLORATIONS LIMITED

Three licences of occupation were obtained by three companies in 1965. These companies were Argor Explorations Limited, Consolidated Morrison Explorations Limited, and Goldray Mines Limited. They formed a consortium to undertake exploration of the licences with initial funding being supplied by Imperial Oil Enterprises Limited. The area was covered by airborne magnetic and electromagnetic surveys at a quarter–mile spacing with northwest–southeast flight lines.

Follow–up diamond drilling of geophysically indicated targets in 1966 identified the Alpha–B anomaly as a pyrochlore–bearing carbonatite.

The company completed a ground magnetometer survey over the carbonatite and completed 47,625 feet (14 287.5 m) of diamond drilling in 85 holes (Stockford 1972). This work outlined a deposit of 62,000,000 tons grading 0.52% Nb_2O_5 (Stockford 1972).

A test shaft was sunk in 1968 to a depth of 133 feet (40 m) and a cross–cut was driven across the deposit to obtain a 250 ton bulk sample for metallurgical testing (Stockford 1972). This testing indicated a concentrate grading 64.0% Nb_2O_5 could be produced from the carbonatite. Work on the property has been discontinued since that time.

RECOMMENDATIONS TO THE PROSPECTOR

Residuum deposits at Argor appear unlikely or are likely to be limited in volume and distribution. Assay data indicate no potential for tantalum and very questionable potential for rare earth elements. The only rare earth element potential may be as a by–product from an apatite concentrate. Apatite occurs in sufficient concentration to warrant consideration as a by–product commodity in any mining operation. Data is inconclusive, but zircon may locally be present in concentrations worthy of consideration for recovery. The carbonatite–pyroxenite contact area should be checked closely for hydrothermal vermiculite. However, exploration at the nearby Cargill complex of similar geology indicates that the existing vermiculite is a near–surface weathering feature. The Cargill vermiculite has no depth potential and thus represents a very limited volume of material. Similar conditions may exist at the Argor complex. The complex has no uranium potential. Disseminated sulphides containing copper and possibly nickel could be present in the pyroxenite even though present data is not encouraging. Niobium is by far the element of main economic interest. Since the niobium values given are from what appears to be primary carbonatite, the mineralized zone is likely to have considerable depth potential.

Appendix A — Petrographic Descriptions, Chemical Analyses and Normative Compositions of Samples from the Argor Carbonatite Complex.

TABLE A-1. PETROGRAPHIC DESCRIPTIONS OF WHOLE-ROCK SAMPLES* FROM THE ARGOR CARBONATITE COMPLEX.

Reference No. 1314
Sample No. A2 172.9-173.2

Sovite.

Fine grained, equigranular, massive, allotriomorphic, with curved grain boundaries. Minor apatite occurs as anhedral rounded grains. Apatite grains are sometimes fractured. Trace amounts of biotite-phlogopite, opaques, and possibly altered pyroxene are present.

Reference No. 1315
Sample No. A2 254.5-254.7

Pyrochlore-bearing, amphibole, apatite sovite.

Fine grained, massive, equigranular, hypidiomorphic with straight to curved grain boundaries. Pyrochlore occurs as euhedral crystals with small inclusions of carbonate. Amphibole is euhedral, prismatic, pleochroic in pale green, and twinned. Apatite forms anhedral rounded grains. Carbonate forms a mosaic of anhedral grains. Fine-grained, granoblastic carbonate occurs between large grains.

Reference No. 1316
Sample No. A2 366.7-367.1

Amphibole, biotite-phlogopite, apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Amphibole is pleochroic in pale green, twinned, and euhedral. Biotite-phlogopite forms red-brown, subhedral, tabular grains. Apatite forms anhedral rounded to rounded-elongate grains. Carbonate is anhedral, forms an interlocking mosaic of grains; locally it appears crushed and recrystallized into fine-grained, granoblastic carbonate. Trace of pyrochlore and disseminated opaques are present. The opaques are likely magnetite.

Reference No. 1317
Sample No. A2 409.3-409.6

Amphibole, apatite, biotite-phlogopite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with curved to straight grain boundaries. Apatite forms anhedral, rounded to rounded-elongate grains. Larger apatite grains may be fractured. Amphibole is euhedral, acicular, twinned, and pleochroic in pale green. Opaques are anhedral and disseminated. Biotite-phlogopite is subhedral, tabular, and pleochroic in red-brown. Biotite-phlogopite encloses rounded blebs of carbonate.

Reference No. 1318
Sample No. A2 467.3-467.6

Apatite, amphibole sovite.

Fine to medium grained, massive, equigranular, with curved to straight grain boundaries. Amphibole is euhedral, twinned, pleochroic in pale green. It may enclose carbonate. Slight colour mottling of larger grains suggests composition variation from core to rim. Apatite forms rounded, anhedral grains. Carbonate occurs as a mosaic of interlocking anhedral grains. Minor amounts of biotite-phlogopite and disseminated opaques, likely magnetite, are present.

Reference No. 1319
Sample No. A2 519.7-520.0

Biotite-phlogopite, apatite, amphibole sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with curved to straight grain boundaries. Apatite is anhedral and forms rounded to subrounded grains; larger

**All samples are from drill core of Consolidated Morrison Explor. Ltd. The locations of the drill holes are shown on Figures 3-5 (Chart A). Sample numbers indicate the depth in feet of the core sample.*

grains are fractured and may enclose carbonate plus amphibole. Amphibole forms euhedral, twinned crystals, pleochroic in pale green. Biotite–phlogopite is subhedral, tabular, and displays weak kinking; it encloses apatite and amphibole. Carbonate forms a mosaic of interlocking grains; locally the rock appears crushed and recrystallized into finer grained granoblastic carbonate.

Reference No. 1320
Sample No. A2 569.6–570.0

Biotite–phlogopite, amphibole, apatite sovite.

Fine to medium grained, massive hybrid, with serrate to straight grain boundaries. Apatite forms anhedral, rounded grains, and may enclose carbonate and amphibole. Amphibole is euhedral, twinned, acicular and pleochroic in pale green. Biotite–phlogopite is subhedral, tabular and may contain small amphibole crystals. Opaques are anhedral, disseminated and may enclose tiny carbonate veins. Carbonate forms a mosaic of interlocking anhedral grains. Carbonate grain boundaries are serrate and may be recrystallized. Traces of pyrochlore are present.

Reference No. 1321
Sample No. A2 609.2–609.5

Opaques, apatite, biotite–phlogopite, amphibole sovite.

Fine to medium grained, massive, inequigranular–seriate, hypidiomorphic, with straight to lobate grain boundaries. Amphibole is euhedral, acicular, pleochroic in green. Apatite forms anhedral rounded grains and may enclose amphibole. Biotite–phlogopite is subhedral, tabular and may enclose amphibole, apatite, carbonate, opaques. Opaques are anhedral, disseminated, and enclose amphibole blebs. Pyrochlore is anhedral and poikilitically encloses carbonate. Carbonate forms a mosaic of anhedral interlocking grains; grains are locally finer grained and appear recrystallized.

Reference No. 1322
Sample No. A2 662.7–663.0

Apatite, amphibole sovite.

Fine grained, massive, equigranular, hypidiomorphic with straight to curved grain boundaries. Amphibole is euhedral, acicular, and twinned. Apatite forms rounded to rounded elongate anhedral grains which may enclose amphibole. Carbonate forms anhedral interlocking mosaic of grains. Some fine–grained, granoblastic carbonate occurs along boundaries of larger carbonate grains.

Reference No. 1323
Sample No. A2 708.2–708.5

Pyrochlore and zircon–bearing biotite–phlogopite, amphibole sovite.

Fine to medium grained, massive, inequigranular–seriate, hypidiomorphic, with straight to lobate grain boundaries. Zircon is subhedral, and one grain displays a dark halo in biotite due to radioactive bombardment. Pyrochlore is euhedral and displays a slightly browner core than zircon. Brown core often has a grey rim and thus the pyrochlore may be zoned. Biotite–phlogopite is subhedral, tabular; it may enclose opaques, carbonate and apatite. Amphibole is euhedral, acicular, pleochroic in pale green, twinned and encloses carbonate. Minor anhedral disseminated opaques are likely magnetite.

Reference No. 1324
Sample No. A2 731.2–731.5

Biotite–phlogopite, apatite, amphibole sovite.

Fine to medium grained, massive, inequigranular–seriate, hypidiomorphic, with straight to lobate grain boundaries. Amphibole is euhedral, acicular, twinned, and pleochroic in pale green. Apatite forms rounded grains and may enclose grains of amphibole and carbonate. Biotite–phlogopite is anhedral, tabular and may enclose carbonate blebs. Carbonate forms a mosaic of anhedral, interlocking grains; larger grains are set in a matrix of finer grained recrystallized carbonate with lobate grain boundaries. Minor disseminated, anhedral opaques are likely magnetite.

Reference No. 1325
Sample No. A2 784.2–784.5

Apatite, biotite–phlogopite, amphibole sovite.

Fine to medium grained, massive, inequigranular–seriate, hypidiomorphic, with straight to lobate grain boundaries. Biotite–phlogopite occurs as anhedral, tabular grains with weak bend-

ing of (001) cleavage; it may enclose amphibole grains. Minor pyrochlore forms zoned subhedral crystals with grey rims. Locally it encloses carbonate. Amphibole is euhedral, acicular, twinned, with pale green pleochroism. Apatite occurs as anhedral, rounded grains. Carbonate forms a mosaic of interlocking anhedral grains; larger grains are separated by finer grained areas of carbonate.

Reference No. 1326
Sample No. A2 852.7-852.9

Pyrochlore bearing, biotite-phlogopite, apatite, amphibole sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with curved to straight grain boundaries. Minor pyrochlore occurs as grey grains, euhedral to subhedral in form and enclosing carbonate blebs. Amphibole is euhedral, acicular, twinned and pleochroic in pale green. Apatite is anhedral, rounded to rounded-elongate in form. Biotite-phlogopite is anhedral, subhedral, tabular, with bent (001) cleavage. Carbonate forms an interlocking mosaic of anhedral grains. Trace amounts of disseminated, anhedral opaques are most likely magnetite.

Reference No. 1327
Sample No. A2 918.5-919.0

Apatite, amphibole sovite.

Fine to medium grained, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Amphibole is acicular, euhedral, pleochroic in pale green. Apatite is anhedral and elongate; larger grains are fractured and healed with carbonate. Carbonate is an anhedral interlocking mosaic and appears granoblastic with curved grain boundaries. Minor opaques form anhedral disseminated grains. Opaques contain carbonate blebs. Traces of pyrochlore are present.

Reference No. 1328
Sample No. A2 926.5-926.9

Magnetite, biotite-phlogopite, amphibole, apatite sovite.

Fine to medium grained, inequigranular-seriate, hypidiomorphic, with lobate to straight grain boundaries. Apatite forms anhedral, rounded to rounded-elongate anhedral crystals. Opaques are anhedral, disseminated with carbonate blebs. Biotite-phlogopite forms subhedral grains that are tabular and commonly associated with magnetite; scattered grains have bent and kinked (001) cleavage. Amphibole is euhedral, acicular, pleochroic in pale green; it locally encloses carbonate, and rarely encloses an opaque. Some amphibole grains appear fractured. Carbonate is an anhedral interlocking mosaic; larger grains are set in a finer grained carbonate matrix. Traces of pyrochlore are present.

Reference No. 1329
Sample No. A2 942.6-943.1

Magnetite, biotite-phlogopite, amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Magnetite is anhedral, disseminated and may contain blebs of enclosed carbonate. Biotite-phlogopite is anhedral to subhedral, forming tabular crystals. Crystals show bent and kinked (001) cleavage. Amphibole is euhedral, acicular, weakly fractured, and pleochroic in pale green. It contains blebs of carbonate and disseminated magnetite. Apatite is anhedral and forms rounded to rounded elongate grains which are commonly fractured and cemented with carbonate. Apatite may enclose blebs of carbonate. Pyrochlore is uncommon, rounded, brown in colour and contains carbonate blebs. Minor sphene is present. Carbonate forms an anhedral mosaic of interlocking grains; smaller grains occur along edges of larger grains; possibly some has recrystallized.

Reference No. 1330
Sample No. A2 977.7-977.9

Apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to lobate grain boundaries. Apatite forms rounded anhedral grains. Biotite-phlogopite is subhedral, tabular and kinked. Amphibole is euhedral, pleochroic in pale green, and encloses biotite and carbonate blebs. Opaques are anhedral, disseminated. Carbonate forms a mosaic of anhedral interlocking grains. Larger grains are enclosed in a finer grained granoblastic-appearing matrix of carbonate and display bent rhombohedral twin planes. Carbonate is deformed and recrystallized.

Reference No. 1331
Sample No. A2 988.1-988.7

Biotite-phlogopite silicocarbonatite.

Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. The rock is protoclastic. Opaques are anhedral, disseminated, and are likely magnetite. Amphibole occurs in trace amounts. Biotite-phlogopite is anhedral to subhedral, tabular, with well developed kink banding and bent (001) cleavage. Carbonate forms a mosaic of interlocking subhedral grains. Minor anhedral apatite is present.

Reference No. 1332
Sample No. A2 998.2-998.5

Magnetite, apatite, amphibole sovite.

Fine grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Carbonate matrix appears granoblastic. Apatite forms anhedral, rounded to rounded-elongate grains. Opaques are anhedral and disseminated. Amphibole is euhedral, twinned, pleochroic in pale green, and some grains are fractured. Carbonate is unusually fine grained and appears crushed and recrystallized-granoblastic. Trace amounts of biotite-phlogopite and pyrochlore are present.

Reference No. 1333
Sample No. A2 1059.0-1059.7

Magnetite, amphibole, biotite-phlogopite silicocarbonatite.

Fine grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Magnetite is anhedral, disseminated and may occur poikilitic in biotite-phlogopite. Amphibole is anhedral to subhedral with ragged edges; it is internally undergoing ragged replacement by biotite and locally contains blebs of carbonate. Biotite-phlogopite forms anhedral tabular grains with bent (001) cleavage and interlocking in jackstraw pattern; locally it poikilitically encloses magnetite and carbonate. Carbonate is anhedral, interstitial. Trace to minor amounts of sphene occur as aggregate of several grains.

Reference No. 1334
Sample No. A2 1110.9-1111.6

Amphibole, magnetite, biotite-phlogopite silicocarbonatite.

Medium to coarse grained, inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. Amphibole is subhedral to anhedral, pale green in colour; crystals are stubby rather than prismatic. It contains rounded blebs of carbonate. Biotite-phlogopite forms subhedral tabular grains interlocking in a jackstraw pattern. It may contain small poikilitic grains of magnetite. Magnetite is anhedral, disseminated and large grains may contain blebs of carbonate. Carbonate is anhedral and interstitial.

Reference No. 1335
Sample No. A2 1122.8-1123.5

Carbonated magnetite pyroxenite.

Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with straight to curved grain boundaries. Magnetite is anhedral to coarse grained. Biotite-phlogopite forms anhedral grains with bent (001) cleavage. Mica contains carbonate and magnetite inclusions. Clinopyroxene is anhedral to euhedral, colourless and contains inclusions of carbonate and magnetite. Amphibole after pyroxene is very pale green and mantles pyroxene. Carbonate is anhedral and interstitial.

Reference No. 1336
Sample No. A2 1183.0-1183.8

Carbonated amphibole pyroxenite.

Fine to coarse grained, massive, inequigranular-seriate, allotriomorphic to hypidiomorphic, with straight to curved grain boundaries. Amphibole is turbid and appears locally to have a woody or splintery appearance. This amphibole is generally colourless. A pale green amphibole is interstitial and marginal to some clinopyroxene; this amphibole replaces clinopyroxene and is pleochroic in pale green to brown. Amphibole contains inclusions of magnetite and biotite-phlogopite. Clinopyroxene is anhedral to euhedral, colourless and encloses opaques, biotite and carbonate. Marginally and internally the pyroxene is undergoing replacement by greenish amphibole. Magnetite is anhedral to subhedral and encloses carbonate and amphibole. Carbonate

forms anhedral interstitial grains. Trace to very minor amounts of biotite-phlogopite are present.

Reference No. 1337
Sample No. AB3 432.2-432.4

Pyrochlore-bearing, biotite-phlogopite, apatite, sovite.

Fine grained, massive, equigranular, hypidiomorphic, with curved to straight grain boundaries. Minor pyrochlore is anhedral to subhedral, grey to red-brown grains; it may enclose rounded blebs of carbonate. Biotite-phlogopite forms subhedral, tabular grains. Apatite forms rounded to rounded elongate grains. Minor subhedral amphibole is acicular, pleochroic in pale green. Concentric colour mottling of the amphibole under cross nicols suggests compositional zoning. Carbonate occurs as a mosaic of anhedral, interlocking grains with lobate grain boundaries.

Reference No. 1338
Sample No. AB3 443.2-443.4

Apatite, biotite-phlogopite silicocarbonatite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Trace amounts of sphene form anhedral grains with rounded blebs of carbonate. Traces of opaques are present. Biotite-phlogopite forms subhedral tabular grains, with weak bending of (001) cleavage in larger grains. Apatite grains are anhedral and rounded to rounded-elongate. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1339
Sample No. AB3 472.2-472.4

Pyrochlore-bearing, apatite, amphibole sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Minor pyrochlore forms subhedral grains of red-brown colour with darker cores and lighter rims, and contains rounded inclusions of carbonate. Apatite grains are anhedral, rounded to rounded-elongate. Apatite may contain rounded carbonate inclusions and subangular amphibole inclusions. Amphibole is subhedral to euhedral, acicular, twinned, pleochroic in pale green; crystals are clotty with long axes subparallel. Concentric colour bands seen under crossed nicols indicate some larger amphibole crystals may be compositionally zoned. Carbonate forms an interlocking mosaic of anhedral grains.

Reference No. 1340
Sample No. AB3 485.8-486.0

Pyrochlore, biotite-phlogopite, amphibole, apatite sovite.

Fine to medium grained, equigranular, massive, hypidiomorphic, with straight to lobate grain boundaries. Biotite-phlogopite grains are subhedral, tabular, with kink banding of (001) cleavage, and have amphibole inclusions. Biotite-phlogopite partially encloses a pyrochlore grain. Pyrochlore is present as anhedral to subhedral, grey to red-brown grains. Pyrochlore has abundant rounded inclusions of carbonate. Amphibole is euhedral, acicular, twinned, pleochroic in pale green. Apatite is anhedral and rounded to rounded-elongate. Carbonate occurs as an interlocking mosaic of anhedral grains. Carbonate appears crushed and recrystallized with serrate grain boundaries.

Reference No. 1341
Sample No. AB3 538.2-538.4

Magnetite, amphibole, apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to serrate grain boundaries. Magnetite is anhedral, disseminated and may contain inclusions of apatite and amphibole. Amphibole forms euhedral, acicular, twinned crystals, pleochroic in pale green. Apatite forms rounded to rounded-elongate grains which may enclose grains of amphibole or traces of biotite-phlogopite with tiny amphibole inclusions. Carbonate is anhedral and forms an interlocking mosaic. Carbonate is very fine grained along grain boundaries and may be recrystallized. Carbonate grain boundaries are serrate.

Reference No. 1342
Sample No. AB3 578.2-578.4

Amphibole, apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with curved to straight grain boundaries. Minor opaques are anhedral, disseminated, and may enclose amphibole crystals.

Opaques are likely to be magnetite. Apatite is anhedral, rounded to rounded-elongate; it may contain inclusions of amphibole, carbonate and magnetite. Amphibole is euhedral, acicular, twinned, and pleochroic in pale green. Carbonate appears to be of two types and has serrate grain boundaries; it is possibly recrystallized.

Reference No. 1343
Sample No. AB3 594.3-594.5

Pyrochlore-bearing, biotite-phlogopite, apatite, amphibole sovite.

Fine to medium grained, equigranular, massive, hypidiomorphic, with straight to curved grain boundaries. Biotite-phlogopite occurs as subhedral, tabular grains with needle-like amphibole inclusions and small rounded blebs of carbonate. Minor pyrochlore forms euhedral grey crystals which are concentrically zoned and contains blebs of carbonate. Amphibole is euhedral, acicular, twinned, and pleochroic in pale green. It may contain rounded blebs of carbonate. Apatite forms rounded to rounded-elongate grains, some with crudely cuspate grain margins. Apatite may contain anhedral amphibole and rounded blebs of carbonate. Carbonate forms a mosaic of anhedral interlocking grains. Traces of opaques are present.

Reference No. 1344
Sample No. AB3 628.2-628.4

Pyrochlore-bearing, magnetite, biotite-phlogopite, apatite, amphibole sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to lobate grain boundaries. Possibly some recrystallization has occurred. The opaque mineral, likely magnetite, is anhedral, disseminated, and may enclose blebs of carbonate. Biotite-phlogopite is anhedral to subhedral, tabular, and may enclose rounded blebs of carbonate and acicular amphibole crystals. Amphibole is euhedral, acicular, twinned, and pleochroic in pale green. Minor pyrochlore forms euhedral to subhedral grey grains. Pyrochlore may enclose rounded blebs of carbonate. Apatite occurs as rounded to rounded-elongate grains; some grain boundaries appear cuspate. Carbonate is anhedral, interlocking and forms a mosaic of interlocking grains. Locally patches of carbonate are finer grained with lobate grain boundaries. Locally carbonate appears recrystallized.

Reference No. 1345
Sample No. AB3 643.2-643.4

Pyrochlore-bearing, magnetite, biotite-phlogopite, amphibole, apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to lobate grain boundaries. Biotite-phlogopite forms anhedral to subhedral grains with bent (001) cleavage, and with rounded inclusions of carbonate and acicular amphibole. The opaque mineral, likely magnetite, is anhedral, disseminated, and may enclose rounded grains of carbonate. Apatite forms rounded to rounded-elongate grains which may enclose rounded blebs of carbonate or subhedral grains of amphibole. Some apatite grains are fractured. One grain contains a rounded grain of pyrochlore. Amphibole is euhedral, twinned, acicular, pleochroic in pale green, and may enclose rounded grains of carbonate. Carbonate forms an interlocking mosaic of anhedral grains. Carbonate grain boundaries are lobate. Two carbonates are intergrown in a eutectic-like fashion. Carbonate is possibly recrystallized. Pyrochlore forms anhedral to euhedral red-brown to grey grains. Some grains are crudely concentrically zoned.

Reference No. 1346
Sample No. AB3 698.8-699.0

Magnetite, biotite-phlogopite, amphibole, apatite sovite.

Fine to medium grained, equigranular, massive, hypidiomorphic, with straight to lobate grain boundaries. Biotite-phlogopite forms subhedral tabular grains. Opaques are anhedral to subhedral, disseminated, and may enclose round blebs of carbonate. Apatite is anhedral, rounded to rounded-elongate. Some grains have almost cuspate grain boundaries. Amphibole is euhedral, acicular, and pleochroic in pale green. Carbonate forms a mosaic of anhedral interlocking grains with lobate grain boundaries.

Reference No. 1347
Sample No. AB3 701.8-702.5

Amphibole, apatite, magnetite sovite.

Fine to medium grained, equigranular, massive, hypidiomorphic, with straight to curved grain boundaries. The opaque mineral, likely magnetite, is anhedral, disseminated and may enclose rounded blebs of carbonate. Amphibole is subhedral, prismatic, twinned, pleochroic in green,

and contains rounded blebs of carbonate and subangular magnetite. Apatite forms rounded, anhedral grains. One grain contains a round grain of pyrochlore. Pyrochlore is anhedral, red-brown in colour and rounded. Minor biotite-phlogopite forms tabular, subhedral grains. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1348
Sample No. AB3 737.3-738.1

Biotite-phlogopite, magnetite, amphibole, apatite, sovite.

Fine to medium grained, equigranular, massive, hypidiomorphic, with curved to straight grain boundaries. Biotite-phlogopite forms subhedral, tabular grains; several display kink-bands on (001) cleavage. It may enclose rounded blebs of carbonate. Opaques are anhedral disseminated, and may enclose rounded carbonate and subangular amphibole. Amphibole is subhedral, prismatic, pleochroic in green, and twinned. Amphibole may enclose rounded blebs of carbonate and subangular opaques. Apatite forms rounded to rounded-elongate grains. Carbonate forms a mosaic of anhedral interlocking grains.

Reference No. 1349
Sample No. AB3 792.3-793.0

Magnetite, biotite-phlogopite, apatite, amphibole sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. A trace of anhedral disseminated sphene is present. Biotite-phlogopite is subhedral, tabular, and may enclose a grain of opaques. Amphibole is euhedral, acicular, twinned, and pleochroic in pale green. It may enclose rounded blebs of carbonate, magnetite and very small tabular biotite-phlogopite grains. One grain contains several very small pyrochlore grains. Apatite forms anhedral, rounded to rounded-elongate grains. Opaques, likely magnetite, are anhedral, disseminated, and commonly associated with biotite-phlogopite. Trace amounts of anhedral, rounded, disseminated red-brown pyrochlore are present. Carbonate forms a mosaic of anhedral interlocking grains.

Reference No. 1350
Sample No. AB3 847.0-847.6

Biotite-phlogopite, magnetite, amphibole, apatite sovite.

Fine to medium grained, equigranular, massive, hypidiomorphic, with straight to curved grain boundaries. Biotite-phlogopite forms anhedral to subhedral tabular grains with weak bending of (001) cleavage; it may enclose amphibole and carbonate inclusions. The opaque mineral, likely magnetite, occurs as anhedral disseminated grains that may enclose rounded blebs of carbonate and tabular grains of biotite-phlogopite. Trace amounts of sphene enclose carbonate and interlock with magnetite. Amphibole is euhedral, acicular, twinned, and pleochroic in pale green. It may enclose rounded carbonate grains or anhedral opaques. Apatite forms anhedral, rounded to rounded-elongate grains which enclose rounded grains of carbonate. Carbonate occurs as a mosaic of interlocking anhedral grains.

Reference No. 1351
Sample No. AB3 984.0-984.6

Hornblendite.

Fine to coarse grained, massive, inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. Amphibole grains are anhedral, interlocking, with woody textures; may enclose tiny opaques, apatite, and biotite inclusions. Apatite occurs as very tiny elongate grains. Kink-bands cross one grain. Minor biotite-phlogopite occurs along fractures in amphibole as small grains. Rarely is biotite-phlogopite enclosed in amphibole. Trace amounts of carbonate occur along fractures and as isolated grains in amphibole. Opaques and apatite are present in trace quantities.

Reference No. 1352
Sample No. AB3 1037.6-1038.7

Amphibole, magnetite pyroxenite.

Fine to coarse grained, massive, inequigranular-seriate, allotriomorphic, granoblastic, with straight to curved grain boundaries. Amphibole is anhedral, turbid, possibly in part an alteration after pyroxene. It locally encloses opaques and apatite. Amphibole occurs as a narrow reaction rim between magnetite and clinopyroxene. Trace amounts of apatite are present. Clinopyroxene is anhedral, colourless, slightly turbid and locally granoblastic in appearance. Amphibole is clearly altering from clinopyroxene. Pyroxene may enclose magnetite. Locally the

clinopyroxene alteration to amphibole is patchy. The opaque mineral, likely magnetite, is anhedral and interstitial to clinopyroxene and traces of apatite. Minor biotite–phlogopite is anhedral and appears to be a possible alteration of amphibole.

Reference No. 1353
Sample No. AB3 1040.2–1041.1

Magnetite, apatite, amphibole pyroxenite.

Fine to medium grained, massive, inequigranular–seriate, allotriomorphic, with curved to straight grain boundaries. The opaque mineral, likely magnetite, occurs as anhedral grains which may enclose apatite. Apatite is anhedral and forms a mosaic of anhedral grains. Adjacent grains have a granoblastic texture. Biotite–phlogopite is anhedral, tabular, and may enclose small apatite inclusions and small opaque inclusions. It appears to be in part replacing pyroxene. Carbonate is anhedral and interstitial. Amphibole is anhedral, pleochroic in brown, and may enclose apatite and opaques. It possibly replaces clinopyroxene. Clinopyroxene is anhedral, interlocking, brown in colour and turbid. Clinopyroxene encloses apatite, magnetite and may be altering to biotite–phlogopite and amphibole. One grain of biotite–phlogopite encloses a small grain of clinopyroxene.

Reference No. 1354
Sample No. AB3 1075.5–1076.1

Amphibole, apatite pyroxenite.

Fine to coarse grained, massive, inequigranular–seriate, allotriomorphic, with curved to straight grain boundaries. Apatite is anhedral and interlocking. Interlocking apatite grains display a granoblastic texture. Biotite–phlogopite forms anhedral, tabular grains, often with bent (001) cleavage. It may contain small apatite inclusions and small opaque inclusions. Opaques, likely magnetite, are anhedral, disseminated and may enclose biotite–phlogopite. Amphibole forms anhedral, irregular grains pleochroic in brown. It may enclose apatite. Clinopyroxene is anhedral, interlocking, and may enclose apatite. Pyroxene encloses and is intergrown with apatite; clinopyroxene is turbid and brownish in colour.

Reference No. 1355
Sample No. AB3 1090.8–1091.6

Amphibole pyroxenite.

Fine to coarse grained, massive, inequigranular–seriate, allotriomorphic, with curved to straight grain boundaries. Apatite is anhedral and interstitial. Amphibole forms anhedral crystals, pleochroic in brown, and may enclose apatite. Clinopyroxene is anhedral, colourless, interlocking and may enclose apatite. Opaques are likely magnetite and are anhedral and disseminated. Minor tabular, anhedral, biotite–phlogopite with bent twin lamellae is possibly after amphibole. Trace amounts of carbonate are present.

Reference No. 1356
Sample No. AB3 1142.6–1143.6

Apatite hornblendite.

Fine to medium grained, massive, inequigranular–seriate, allotriomorphic, with straight to curved grain boundaries. Minor anhedral, interstitial carbonate is present. Traces of relict pyroxene are present. Minor anhedral disseminated opaques are possibly magnetite. Apatite forms anhedral interstitial grains. Apatite appears granoblastic where several grains interlock. It may be poikilitic in amphibole. Amphibole is anhedral, pleochroic in brown, and may enclose apatite and opaques. Biotite–phlogopite forms anhedral tabular brown grains, and appears to be replacing amphibole.

Reference No. 1357
Sample No. AB3 1178.7–1179.2

Apatite pyroxenite.

Fine to coarse grained, inequigranular–seriate, allotriomorphic, with straight to curved grain boundaries. Apatite forms rounded anhedral grains. Interlocking apatite grains have a granoblastic texture. Opaques are anhedral, disseminated, and interstitial. Clinopyroxene is anhedral, interlocking and may enclose apatite grains. Amphibole is minor and anhedral; it is possibly altered clinopyroxene.

Reference No. 1358
Sample No. AB 266.3–266.8

Amphibole, apatite sovite.

Fine grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Amphibole is euhedral, twinned, acicular, pleochroic in pale green. Apatite is anhedral and

forms rounded to rounded-elongate grains. Carbonate forms an interlocking mosaic of anhedral grains, with serrate grain boundaries. Minor opaques are most likely magnetite. Trace amounts of pyrochlore are present.

Reference No. 1359
Sample No. A8 309.3-309.6

Amphibole, apatite sovite.

Fine grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Amphibole is euhedral, acicular, twinned, and pleochroic in pale green. Apatite forms anhedral, rounded to rounded-elongate grains. Minor biotite-phlogopite displays bent (001) cleavage. Minor magnetite contains blebs of carbonate and a rare grain of biotite-phlogopite.

Reference No. 1360
Sample No. A8 323.3-323.6

Apatite, amphibole sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Amphibole is acicular, euhedral, twinned, and pleochroic in pale green. Apatite is euhedral to anhedral and rounded to rounded-elongate. Traces of opaques are present. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1361
Sample No. A8 363.6-364.0

Pyrochlore-bearing, amphibole, apatite sovite.

Fine grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Pyrochlore is euhedral, grey in colour and contains blebs of carbonate. Amphibole is acicular, euhedral, twinned, and pleochroic in pale green. Apatite forms rounded anhedral grains and encloses carbonate and amphibole. Trace amounts of disseminated, anhedral magnetite are present. Carbonate forms a mosaic of interlocking grains with bent rhombohedral twinning in larger grains; fine-grained recrystallized carbonate occurs along grain boundaries.

Reference No. 1362
Sample No. A8 407.7-408.3

Biotite-phlogopite, amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with curved to straight grain boundaries. Biotite-phlogopite forms subhedral, tabular grains and contains inclusions of amphibole and carbonate. Amphibole is euhedral, acicular, twinned and pleochroic in pale green. Apatite forms anhedral, rounded to rounded-elongate crystals which may contain inclusions of carbonate and amphibole. Traces of sphene and minor anhedral disseminated magnetite are present. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1363
Sample No. A8 418.5-418.9

Pyrochlore-bearing, biotite-phlogopite, magnetite, apatite, amphibole sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Carbonate looks crushed and recrystallized. Minor pyrochlore forms grey, euhedral crystals with carbonate blebs. Amphibole is euhedral, acicular, twinned and pleochroic in pale green. Apatite is anhedral, rounded to rounded-elongate, and encloses amphibole crystals and rounded blebs of carbonate. Biotite-phlogopite is anhedral, tabular and displays local kinking and bending of (001) cleavage. The magnetite is anhedral, disseminated, and contains occasional carbonate blebs. Carbonate forms an interlocking mosaic of grains. Larger grains are set in a mosaic of fine-grained, granoblastic recrystallized carbonate. Rhombohedral twin planes of larger grains are bent.

Reference No. 1364
Sample No. A8 455.9-456.3

Pyrochlore bearing, biotite-phlogopite, magnetite, apatite, amphibole sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to serrate grain boundaries. Biotite-phlogopite is anhedral to euhedral, tabular in shape and may contain inclusions of carbonate. Apatite occurs as anhedral, rounded to rounded-elongate grains. Some grains are fractured and some contain rounded blebs of carbonate or amphibole

crystals. Amphibole is euhedral, twinned, acicular and pleochroic in pale green. Magnetite is anhedral, disseminated and may enclose blebs of carbonate. Pyrochlore occurs as euhedral grey crystals with enclosed blebs of carbonate. Carbonate forms an interlocking mosaic of anhedral grains with serrate grain boundaries.

Reference No. 1365
Sample No. AS 476.2-476.6

Pyrochlore bearing, biotite-phlogopite, amphibole, apatite sovite.

Fine grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Pyrochlore is euhedral and forms grey crystals with carbonate inclusions; cores of some grains are very dark and some grains may be zoned. Biotite-phlogopite is subhedral, forms tabular crystals with amphibole crystals and carbonate inclusions. Amphibole forms acicular, twinned, euhedral, rounded to rounded-elongate grains. Opaques are anhedral, disseminated and associated with mica. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1366
Sample No. AS 732.1-732.3

Biotite-phlogopite, magnetite, amphibole, apatite sovite.

Fine grained, massive, inequigranular-seriate, hypidiomorphic, with straight to lobate grain boundaries. Carbonate appears crushed and recrystallized. Biotite-phlogopite is subhedral, tabular, and may display weak bending of (001) cleavage. Opaques are anhedral, disseminated, and may enclose blebs of carbonate. Apatite is anhedral and forms rounded to rounded-elongate grains. Amphibole is euhedral, acicular, pleochroic in pale green, and larger crystals contain blebs of carbonate. Carbonate is anhedral and forms a mosaic of interlocking grains. Larger carbonate grains are set in a matrix of finer grained carbonate. Several larger grains display weak bending of rhombohedral twin planes. Trace amounts of pyrochlore are present.

Reference No. 1366A
Sample No. AS 740.6-741.0

Amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to lobate grain boundaries. Carbonate appears crushed and recrystallized. Amphibole is acicular, euhedral, twinned, and pleochroic from colourless to pale green. Apatite occurs as anhedral, rounded to rounded-elongate grains. Carbonate is anhedral and forms a mosaic of interlocking grains. Larger carbonate grains are enclosed in a mosaic of finer grained carbonate. Carbonate has lobate grain boundaries.

Reference No. 1367
Sample No. AS 832.2-832.7

Magnetite, biotite-phlogopite sovite.

Fine grained, massive, inequigranular-seriate, allotriomorphic, with straight to lobate grain boundaries. Opaques, likely magnetite, are anhedral, disseminated and may enclose carbonate blebs. One grain is skeletal. Biotite-phlogopite forms subhedral tabular grains. Minor apatite forms anhedral rounded grains. Traces of amphibole and pyrochlore are present. Carbonate forms a mosaic of interlocking anhedral grains with rare bent rhombohedral twin planes on several grains. Carbonate grain boundaries are lobate.

Reference No. 1368
Sample No. AS 843.6-844.0

Apatite, biotite-phlogopite silicocarbonatite.

Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, protoclastic, with straight to curved grain boundaries. Apatite forms anhedral, rounded to rounded-elongate grains. Apatite is fractured and healed with carbonate. Biotite-phlogopite forms anhedral tabular grains with bent and kinked (001) cleavage. It encloses blebs of carbonate. Carbonate forms an interlocking mosaic of anhedral grains with bent rhombohedral twin planes. There are local patches of finer grained carbonate and some scattered euhedral rhombs of carbonate in the finer grained carbonate.

Reference No. 1369
Sample No. AS 880.6-881.2

Biotite-phlogopite, apatite sovite.

Fine grained, equigranular, massive, hypidiomorphic, with straight to lobate grain boundaries. Apatite forms rounded and elongate grains with embayed margins. Minor amphibole crystals

are euhedral, acicular, twinned, and pleochroic in pale green. Biotite-phlogopite forms anhedral, tabular grains and may enclose carbonate. Minor anhedral disseminated opaques are present. Carbonate forms a mosaic of anhedral grains with lobate grain boundaries. Locally finer grained granoblastic carbonate occurs along grain boundaries.

Reference No. 1370
Sample No. A8 889.0-889.4

Magnetite, biotite-phlogopite, amphibole, apatite sovite.

Fine grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Apatite forms euhedral, rounded to rounded-elongate grains. It may enclose carbonate, magnetite and amphibole. Amphibole forms euhedral, acicular, twinned crystals, pleochroic in pale green. Pyrochlore occurs in trace quantities as euhedral brown grains with blebs of carbonate and grains of biotite-phlogopite. Trace of zircon is associated with biotite. Dark radioactive bombardment haloes enclose zircon in biotite. Opaques, likely magnetite, occur as anhedral disseminated grains and may enclose biotite-phlogopite, amphibole and carbonate. The biotite-phlogopite forms tabular grains and may enclose amphibole and carbonate blebs. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1371
Sample No. A8 932.8-933.3

Apatite, magnetite, amphibole sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Amphibole forms euhedral, twinned, acicular crystals, pleochroic in pale green. Opaques, likely magnetite, are anhedral, disseminated and enclose amphibole and carbonate. Apatite forms anhedral, rounded to rounded-elongate grains; apatite may enclose rounded blebs of carbonate. Carbonate forms an interlocking mosaic of anhedral grains. One or two grains of possible euhedral carbonate crystals occur within larger carbonate grains.

Reference No. 1372
Sample No. A8 939.4-939.8

Magnetite, apatite, amphibole sovite.

Fine grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Apatite forms anhedral, rounded to rounded-elongate crystals and may enclose amphibole and carbonate. Amphibole forms euhedral, acicular, twinned crystals, pleochroic in pale green. It may enclose carbonate. Opaques, likely magnetite, are anhedral to subhedral in outline and contain inclusions of carbonate and amphibole. Carbonate forms an interlocking mosaic of anhedral grains with lobate grain boundaries.

Reference No. 1373
Sample No. A8 977.6-978.1

Magnetite, amphibole, apatite sovite.

Fine grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Amphibole forms euhedral, acicular, twinned crystals, pleochroic in pale green, and may enclose carbonate blebs, magnetite and sphene. Apatite is anhedral and rounded to rounded-elongate. It may enclose blebs of carbonate, grains of amphibole, and rarely sphene. Biotite-phlogopite is minor, occurring as tabular, subhedral grains. Trace amounts of pyrochlore form red-brown grains. Carbonate forms an interlocking mosaic of anhedral grains with lobate grain boundaries. Magnetite is anhedral, disseminated and may enclose amphibole and carbonate inclusions.

Reference No. 1374
Sample No. A8 998.7-999.1

Amphibole, biotite-phlogopite, apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Trace amounts of brown pyrochlore are enclosed in apatite. Biotite-phlogopite is subhedral, tabular, and encloses the occasional grain of carbonate. Larger biotite-phlogopite grains have bent (001) cleavage. Apatite forms anhedral rounded grains; cuspate margins suggest resorption. Opaques are anhedral and disseminated. Amphibole is euhedral, acicular, and pleochroic in pale green. Amphibole may enclose carbonate grains.

Reference No. 1375
Sample No. A8 1036.5-1037.0

Biotite-phlogopite, magnetite, apatite sovite.

Fine to medium grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Biotite-phlogopite forms anhedral tabular crystals and may contain small blebs of

carbonate. Magnetite is anhedral and disseminated. Apatite is anhedral and forms rounded to rounded-elongate grains. Minor amphibole is subhedral and pale green in colour. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1376
Sample No. A8 1081.3-1081.6

Magnetite, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Trace amounts of red-brown pyrochlore are present. Apatite is anhedral and forms rounded to rounded-elongate crystals. Apatite may enclose biotite-phlogopite grains. Minor amphibole is euhedral to subhedral and pleochroic in pale green. Opaques, likely magnetite, are anhedral and disseminated. Minor biotite-phlogopite forms tabular subhedral grains. Carbonate forms an interlocking mosaic of anhedral grains with lobate grain boundaries.

Reference No. 1377
Sample No. A8 1098.4-1098.8

Biotite-phlogopite, amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Biotite-phlogopite forms anhedral to subhedral tabular grains and may enclose carbonate blebs. Amphibole is euhedral, acicular, and pleochroic in pale green. It may contain blebs of carbonate. Apatite forms rounded to rounded-elongate grains. Minor opaques (magnetite) are anhedral and disseminated. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1378
Sample No. A8 1137.8-1138.3

Magnetite, biotite-phlogopite, amphibole, apatite sovite.

Fine to medium grained, massive, hypidiomorphic, with straight to curved grain boundaries. Opaques are anhedral, disseminated and may enclose blebs of carbonate. Trace of zircon in biotite-phlogopite has radioactive bombardment haloes. Biotite-phlogopite is anhedral to subhedral, tabular, and may contain blebs of carbonate. Amphibole is acicular, euhedral, and pleochroic in pale green. Apatite is anhedral and forms rounded to rounded-elongate grains. It may enclose carbonate blebs. Carbonate is anhedral, interlocking and forms a mosaic.

Reference No. 1379
Sample No. A8 1148.4-1148.7

Biotite, phlogopite, amphibole, magnetite, apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Biotite-phlogopite occurs as anhedral to subhedral tabular grains. It may enclose rounded grains of carbonate. Opaques, likely magnetite, are anhedral to subhedral, disseminated and may contain amphibole inclusions. Apatite is anhedral and forms rounded to rounded-elongate grains. Amphibole is present as euhedral, acicular crystals, pleochroic in pale green. Carbonate forms an interlocking mosaic of anhedral grains.

Reference No. 1380
Sample No. A8 1197.6-1198.0

Apatite sovite.

Fine to coarse grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Minor amphibole occurs as euhedral, acicular crystals, pleochroic in pale green. Apatite forms anhedral, rounded to rounded-elongate crystals. Carbonate forms a mosaic of anhedral interlocking grains with lobate grain boundaries.

Reference No. 1381
Sample No. A137 227.7-227.9

Apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. Trace to minor anhedral rounded grains of clinopyroxene are possibly aegirine-augite and altering to a brown turbid unidentified product. Apatite forms anhedral, rounded to rounded-elongate grains. Minor opaques (magnetite) are present as anhedral disseminated grains. Carbonate forms a mosaic of interlocking anhedral grains. A fracture in carbonate is filled with magnetite and granoblastic quartz.

Reference No. 1382
Sample No. A137 296.6-296.8

Pyrochlore-bearing, amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Minor pyrochlore forms euhedral crystals and may enclose carbonate blebs. Pyrochlore is grey in colour and appears concentrically zoned. Amphibole is euhedral, acicular, and pleochroic in pale green. Apatite is anhedral and forms rounded to rounded-elongate grains. Carbonate forms a mosaic of interlocking anhedral grains; it appears crushed and recrystallized. Larger carbonate grains are set in a finer grained matrix. Rhombohedral twin planes in larger grains are bent.

Reference No. 1383
Sample No. A137 318.6-318.8

Apatite, amphibole, biotite-phlogopite, silicocarbonatite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Apatite forms rounded, anhedral grains. Amphibole forms acicular, subhedral, twinned crystals, pleochroic in pale green. Biotite-phlogopite is anhedral to subhedral, and tabular; it may display bending and kinking of (001) cleavage. Carbonate is anhedral and interstitial. Trace amounts of magnetite are present.

Reference No. 1384
Sample No. A137 321.9-322.1

Pyrochlore-bearing, clinopyroxene, biotite-phlogopite, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Clinopyroxene, possibly aegirine-augite, forms euhedral to anhedral, sometimes turbid grains. Trace amounts of sphene are present. Minor pyrochlore forms subhedral grey grains with inclusions of biotite and carbonate. Biotite-phlogopite is anhedral to subhedral and may enclose carbonate blebs. Apatite forms anhedral, rounded to rounded-elongate grains. Carbonate occurs as an interlocking mosaic of anhedral grains. Trace amounts of magnetite and amphibole are present.

Reference No. 1385
Sample No. A137 384.3-384.6

Pyrochlore-bearing, magnetite, biotite-phlogopite, amphibole, apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Pyrochlore occurs as euhedral grey crystals, several with dark turbid cores. Amphibole forms euhedral, acicular, twinned crystals, pleochroic in pale green. Biotite-phlogopite occurs as subhedral tabular crystals. Apatite occurs as rounded to rounded-elongate grains. Apatite encloses pyrochlore, amphibole, carbonate, and biotite-phlogopite. Carbonate forms a mosaic of interlocking anhedral grains. Opaques are likely magnetite and occur as anhedral disseminated grains. Opaques may enclose a small grain of carbonate.

Reference No. 1386
Sample No. A137 437.7-438.0

Pyrochlore-bearing, amphibole, biotite-phlogopite, apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Pyrochlore is euhedral, and occurs as grey crystals which may enclose blebs of carbonate. Some crystals show crude concentric zoning. Amphibole is euhedral, twinned, acicular and pleochroic in pale green. Biotite-phlogopite is anhedral to euhedral, may enclose euhedral amphibole and rounded blebs of carbonate. Apatite is anhedral and rounded to rounded-elongate in form. Opaques are likely magnetite and occur as anhedral disseminated grains. Traces of euhedral to subhedral clinopyroxene are present. Carbonate forms a mosaic of interlocking anhedral crystals.

Reference No. 1387
Sample No. A137 453.1-453.3

Pyrochlore-bearing amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Pyrochlore with weak concentric zoning occurs as anhedral to euhedral grey grains, which may enclose rounded blebs of carbonate. Apatite forms anhedral, rounded to rounded-elongate grains. It may contain inclusions of amphibole, pyrochlore, carbonate. Am-

phibole occurs as acicular, euhedral, twinned crystals, pleochroic in pale green. Trace amounts of anhedral disseminated opaques (magnetite) are present. Biotite–phlogopite forms subhedral, tabular grains in very minor amounts.

Reference No. 1388
Sample No. A137 481.7–482.1

Pyrochlore–bearing, magnetite, amphibole, apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Pyrochlore is euhedral, grey in colour, with rounded blebs of carbonate. Opaques, likely magnetite, are anhedral and contain rounded blebs of carbonate. Amphibole occurs as euhedral, acicular, twinned crystals, pleochroic in pale green. Apatite forms rounded to rounded–elongate anhedral grains. Apatite may enclose rounded blebs of carbonate and euhedral amphibole crystals. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1389
Sample No. A137 488.0–488.3

Pyrochlore–bearing, magnetite, amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular–seriate, with curved to straight grain boundaries. Traces of sphene and clinopyroxene are present. Amphibole forms euhedral, acicular, twinned crystals, pleochroic in pale green. Apatite forms rounded to rounded–elongate grains of anhedral form. It may contain occasional inclusions of amphibole. Pyrochlore forms euhedral grey crystals with rounded blebs of carbonate. Opaques, likely magnetite, are anhedral and disseminated and may contain rare carbonate blebs. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1390
Sample No. A137 492.2–492.4

Pyrochlore–bearing, amphibole, apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Pyrochlore is euhedral to subhedral and may poikilitically enclose euhedral amphibole. Amphibole forms euhedral, acicular, twinned crystals, pleochroic in pale green. Minor anhedral, tabular biotite–phlogopite is present. Apatite forms anhedral, rounded to rounded–elongate grains and may enclose rounded blebs of carbonate. Minor opaques are anhedral and disseminated. Trace amounts of clinopyroxene are present. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1391
Sample No. A137 516.2–516.5

Pyrochlore, amphibole, biotite–phlogopite, magnetite, apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to lobate grain boundaries. Euhedral pyrochlore crystals are grey and enclose rounded blebs of carbonate. Amphibole forms acicular, euhedral, twinned crystals, pleochroic in pale green. Apatite forms anhedral, rounded grains with inclusions of carbonate and amphibole. Some grain boundaries appear cuspate. Biotite–phlogopite forms anhedral, tabular crystals which may enclose amphibole and rounded blebs of carbonate. Opaques are likely magnetite and are anhedral and disseminated. Carbonate forms an anhedral, interlocking mosaic of grains. Grain boundaries are lobate.

Reference No. 1392
Sample No. A137 531.5–531.9

Pyrochlore–bearing, magnetite, amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular–seriate, hypidiomorphic, with straight to curved grain boundaries. Pyrochlore occurs as euhedral, grey grains enclosing rounded blebs of carbonate; there is a faint suggestion of concentric zoning on one grain. Amphibole forms euhedral, acicular, twinned crystals, pleochroic in pale green. Opaques are anhedral, disseminated, and may enclose carbonate blebs and amphibole crystals. Opaques are likely to be magnetite. Apatite forms anhedral, rounded to rounded–elongate crystals and may enclose amphibole crystals as inclusions. One grain contains a pyrochlore inclusion. Trace to minor amounts of biotite–phlogopite are present. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1393
Sample No. A137 559.3–559.6

Magnetite, amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular–seriate, hypidiomorphic, with curved to straight grain boundaries. Apatite forms rounded to rounded–elongate anhedral grains. It may

enclose amphibole crystals, rounded blebs of carbonate, and one grain contains a round grain of pyrochlore. Minor biotite-phlogopite is subhedral, tabular, and displays bent and kinked (001) cleavage. Opaques are anhedral, disseminated, and may contain small inclusions of carbonate. Amphibole is euhedral, acicular, twinned, pleochroic in pale green. Carbonate forms a mosaic of interlocking anhedral grains. Locally carbonate is crushed and recrystallized and has abundant bent rhombohedral twin planes.

Reference No. 1394
Sample No. A137 578.0-578.3

Pyrochlore-bearing, apatite, amphibole, biotite-phlogopite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Pyrochlore forms euhedral, grey and brown crystals with rounded blebs of carbonate. Most grains have brown rims and may be zoned. Amphibole forms euhedral, acicular, twinned crystals, pleochroic in pale green. Biotite-phlogopite forms tabular, subhedral grains and may contain euhedral crystals of amphibole. Minor opaques, most likely magnetite, are anhedral and disseminated. Apatite forms anhedral, rounded and rounded-elongate grains. Apatite encloses amphibole crystals and rounded blebs of carbonate. Carbonate grains are anhedral with lobate grain boundaries and form an interlocking mosaic. Some rhombohedral twin planes are bent.

Reference No. 1395
Sample No. A137 589.1-589.3

Pyrochlore, apatite, biotite-phlogopite, magnetite, amphibole sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Traces of clinopyroxene with brown alteration. Pyrochlore occurs as euhedral brown crystals with circular blebs of carbonate. Amphibole is euhedral, acicular, twinned and pleochroic in pale green. Opaques, likely magnetite, are anhedral, disseminated and may enclose blebs of carbonate and amphibole inclusions. Apatite is anhedral and rounded to rounded-elongate in form. It may enclose amphibole crystals and rounded blebs of carbonate.

Reference No. 1396
Sample No. A137 609.3-609.6

Pyrochlore-bearing, magnetite, amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Minor biotite-phlogopite forms subhedral tabular grains. Commonly it encloses acicular amphibole grains. Opaques are likely magnetite, and form anhedral disseminated grains which may enclose amphibole. Amphibole is euhedral, acicular, twinned, pleochroic in pale green. Apatite occurs as rounded to rounded-elongate grains. Apatite is anhedral and contains inclusions of carbonate, magnetite and amphibole. Minor pyrochlore is present as euhedral grey crystals with rounded inclusions of carbonate. Carbonate forms an interlocking mosaic of anhedral crystals. Several large grains contain bent rhombohedral twin lamellae.

Reference No. 1397
Sample No. A137 617.6-618.1

Pyrochlore-bearing, biotite-phlogopite, amphibole, apatite sovite.

Fine grained, massive, equigranular, hypidiomorphic, with curved to straight grain boundaries. Trace amounts of euhedral grey pyrochlore appear concentrically zoned and may enclose rounded grains of carbonate. Minor disseminated anhedral magnetite is present. Biotite-phlogopite is subhedral and forms tabular crystals with rounded inclusions of carbonate. Amphibole occurs as euhedral, acicular, twinned crystals, pleochroic in pale green. Apatite is present as rounded to rounded-elongate grains. Apatite may enclose amphibole. One or two grains have lobate to cuspate grain boundaries. Carbonate forms a mosaic of anhedral interlocking grains.

Reference No. 1398
Sample No. A137 642.3-642.6

Pyrochlore-bearing, amphibole, apatite sovite.

Fine grained, massive, equigranular, hypidiomorphic, with curved to straight grain boundaries. Minor clinopyroxene is colourless to pale green, euhedral, and altering to a reddish brown mineral. Minor pyrochlore occurs as euhedral, grey grains. Amphibole forms euhedral, acicular, twinned crystals, pleochroic in pale green. Apatite forms rounded to rounded-elongate grains,

and may enclose amphibole grains. Opaques, likely magnetite, are anhedral and disseminated. Carbonate forms a mosaic of anhedral interlocking grains.

Reference No. 1399
Sample No. A137 698.0–698.4

Pyrochlore-bearing, biotite-phlogopite, amphibole, apatite, magnetite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic with straight to curved grain boundaries. Opaques, likely magnetite, are anhedral, disseminated, and may enclose carbonate, amphibole, and biotite grains. Biotite-phlogopite is anhedral to subhedral in outline and may contain blebs of carbonate and crystals of amphibole. Amphibole is euhedral, acicular, twinned, and pleochroic in pale green. Apatite is present as anhedral, rounded to rounded-elongate grains which rarely contain amphibole inclusions. Trace to minor amounts of euhedral, grey pyrochlore are present. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1400
Sample No. A137 704.1–704.3

Biotite-phlogopite, amphibole, apatite sovite.

Fine to medium grained, inequigranular-seriate, hypidiomorphic, with curved to straight grain boundaries. Apatite is anhedral, rounded to rounded-elongate, and contains inclusions of euhedral amphibole and blebs of carbonate. Locally it is irregular in outline with cuspate grain boundaries. Amphibole is euhedral, acicular, twinned, and pleochroic in pale green. Biotite-phlogopite forms anhedral to subhedral tabular crystals, and may contain inclusions of acicular amphibole. Minor anhedral disseminated opaques are present. Carbonate forms an interlocking mosaic of anhedral grains.

Reference No. 1401
Sample No. A137 718.8–719.3

Biotite-phlogopite, amphibole, magnetite, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with curved to straight grain boundaries. Opaques are likely magnetite, anhedral, disseminated and may contain inclusions of carbonate and amphibole. Apatite forms anhedral, rounded to rounded-elongate grains; some grains have cuspate edges. It may enclose the occasional grain of euhedral amphibole. Amphibole is euhedral, acicular, twinned and pleochroic in pale green. Biotite-phlogopite forms subhedral tabular grains and may contain blebs of carbonate and euhedral amphibole crystals. Carbonate forms a mosaic of anhedral interlocking grains.

Reference No. 1402
Sample No. A147 230.7–231.5

Apatite-bearing hornblendite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Amphibole forms anhedral to subhedral, stubby crystals; it may enclose numerous tiny opaque grains of possible magnetite. Amphibole is pleochroic in pale brown to green. Opaques occur as anhedral grains along grain boundaries and as disseminated grains within amphibole. Locally amphibole is altering to ragged tabular biotite-phlogopite with (001) cleavage parallel to amphibole cleavage. Apatite forms anhedral, rounded to rounded-elongate grains interlocking with each other and amphibole. Opaques are anhedral, disseminated, intergranular, and enclosed in amphibole. Trace interstitial carbonate is present. Biotite-phlogopite forms small tabular grains between amphibole and occurs as ragged replacements of amphibole.

Reference No. 1403
Sample No. A147 246.0–246.7

Apatite-bearing hornblendite.

Fine to medium grained, allotriomorphic, granoblastic, protoclastic, with straight to curved grain boundaries. Amphibole forms anhedral ragged grains and may contain inclusions of opaques and biotite-phlogopite. Some of the larger grains are fractured and bent. Larger grains are set in a granoblastic groundmass of amphibole and apatite. Apatite is anhedral, granoblastic, and interlocking with amphibole. Opaques are anhedral, disseminated and commonly occur as inclusions in amphibole. Opaques are likely to be magnetite. Trace amounts of biotite-phlogopite are present.

Reference No. 1404
Sample No. A147 250.9-251.8

Carbonated amphibole pyroxenite.

Fine to coarse grained, massive, inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. Clinopyroxene is anhedral to subhedral, colourless, and encloses opaques and carbonate. It is undergoing patchy replacement by amphibole along edges and internally. Amphibole is anhedral and appears to be a replacement of pyroxene. Amphibole is pleochroic from colourless to very pale green. Opaques, likely magnetite, are anhedral, disseminated, and form small inclusions in pyroxene. Minor anhedral interstitial carbonate is present.

Reference No. 1405
Sample No. A147 270.2-271.8

Carbonated, amphibole pyroxenite.

Fine to coarse grained, massive, inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. Clinopyroxenite forms anhedral, colourless grains, and encloses carbonate and opaques. Pyroxene is altering to amphibole. Amphibole after pyroxene is anhedral, ragged, and encloses opaques, carbonate, and biotite-phlogopite. Minor biotite-phlogopite occurs as tabular grains enclosed in amphibole. Opaques are anhedral, disseminated and occur between mineral grains and as small inclusions in amphibole and pyroxene. Carbonate is anhedral, interstitial.

Reference No. 1406
Sample No. A147 353.0-353.4

Magnetite, biotite-phlogopite, amphibole, apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with curved to straight grain boundaries. Opaques, likely magnetite, are anhedral, disseminated, and were observed to contain a grain of biotite-phlogopite. Biotite-phlogopite forms anhedral to subhedral, tabular grains. Amphibole occurs as euhedral, acicular, twinned crystals, pleochroic in pale green. Apatite is rounded to rounded-elongate. Some grains have cuspate margins. Carbonate forms a mosaic of anhedral interlocking grains.

Reference No. 1407
Sample No. A147 373.4-374.6

Pyrochlore-bearing, magnetite, amphibole, biotite-phlogopite, apatite sovite.

Fine to medium grained, inequigranular-seriate, hypidiomorphic, with curved to straight grain boundaries. Pyrochlore is euhedral, disseminated with rounded blebs of carbonate, and is grey and red-brown in colour. Opaques, likely magnetite, are anhedral and disseminated. Biotite-phlogopite occurs as subhedral to anhedral tabular grains and contains inclusions of carbonate and amphibole. Apatite is present as rounded to rounded-elongate, anhedral crystals. Amphibole is present as euhedral, acicular, twinned grains, pleochroic in pale green. Carbonate is anhedral, forming an interlocking mosaic of grains.

Reference No. 1408
Sample No. A147 405.7-406.1

Pyrochlore-bearing amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Minor opaques, likely magnetite, are anhedral and disseminated. Amphibole occurs as euhedral, acicular, twinned crystals and is pleochroic in pale green. Apatite occurs as anhedral, rounded-elongate to rounded grains, and occasionally contains an amphibole crystal. Minor biotite-phlogopite is present as euhedral to subhedral grains with carbonate inclusions. Carbonate forms an interlocking mosaic of anhedral grains.

Reference No. 1409
Sample No. A147 412.9-413.3

Magnetite, amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Opaques, likely magnetite, are anhedral, disseminated, and observed to enclose apatite and carbonate. Amphibole forms euhedral, acicular, twinned crystals, pleochroic in pale green. Minor biotite-phlogopite is subhedral and tabular in outline. Apatite occurs as anhedral, rounded to rounded-elongate grains. It may contain carbonate blebs, and partially encloses magnetite and amphibole. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1410
Sample No. A147 461.8–462.2

Pyrochlore-bearing, magnetite, amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to lobate grain boundaries; opaques are likely magnetite. Magnetite is anhedral, disseminated and closely associated with amphibole. Amphibole is euhedral, acicular, twinned and pleochroic in pale green. It may contain the occasional bleb of carbonate and one crystal contained a grain of magnetite. Apatite forms anhedral, rounded to rounded-elongate grains. Pyrochlore is euhedral and occurs as grey crystals with rounded blebs of carbonate; possibly a grain of amphibole is also enclosed. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1411
Sample No. A147 473.8–474.2

Amphibole, apatite sovite.

Fine to medium grained, equigranular, massive, hypidiomorphic, with curved to straight grain boundaries. Minor opaques are anhedral, disseminated, and enclose carbonate blebs and amphibole. Opaques are likely to be magnetite. Minor biotite-phlogopite occurs as subhedral tabular grains, which may enclose carbonate grains. Apatite forms anhedral, rounded to rounded-elongate grains. Amphibole is euhedral, twinned, acicular, pleochroic in pale green. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1412
Sample No. A147 501.8–502.2

Pyrochlore-bearing, amphibole, apatite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Minor biotite-phlogopite is present as anhedral tabular grains with euhedral inclusions of amphibole and rounded blebs of carbonate. Minor opaques, likely magnetite, are anhedral, disseminated, and may enclose rounded carbonate grains. Apatite is present as anhedral, rounded to rounded-elongate grains and may enclose acicular crystals of amphibole. Amphibole is euhedral, acicular, twinned, and pleochroic in pale green. Minor pyrochlore is subhedral, and contains inclusions of carbonate and rare magnetite. Carbonate forms an interlocking mosaic of anhedral grains.

Reference No. 1413
Sample No. A147 523.2–523.6

Amphibole, apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic, with straight to curved grain boundaries. Minor opaques are anhedral, disseminated. Opaques are likely to be magnetite. Euhedral amphibole and rounded grains of carbonate are observed enclosed in magnetite. Minor biotite-phlogopite occurs as subhedral grains, tabular in form and commonly contains acicular amphibole inclusions. Apatite is present as rounded to rounded-elongate, anhedral grains. Apatite may enclose rounded blebs of carbonate and euhedral amphibole. Amphibole is euhedral, acicular, twinned, and pleochroic in pale green. Carbonate forms an interlocking mosaic of anhedral grains.

Reference No. 1414
Sample No. A147 532.5–532.9

Pyrochlore-bearing, amphibole, magnetite, biotite-phlogopite sovite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic, with straight to curved grain boundaries. Biotite-phlogopite occurs as subhedral, tabular crystals which may enclose euhedral amphibole and rounded grains of carbonate and magnetite. Minor pyrochlore is present as euhedral, grey crystals. Some crystals display concentric zoning. Opaques, likely magnetite, are disseminated, anhedral, and enclose apatite and carbonate grains. Amphibole forms euhedral, acicular, twinned crystals, pleochroic in pale green. Apatite occurs as anhedral, rounded to rounded-elongate grains. Apatite may contain rounded blebs of carbonate. Carbonate forms an interlocking mosaic of anhedral grains.

TABLE A-2. MAJOR ELEMENT ANALYSES (WEIGHT PERCENT) OF WHOLE-ROCK SAMPLES FROM THE ARGOR CARBONATITE COMPLEX.

	SOVITE						
Ref. No.	1314	1315	1316	1317	1318	1319	1320
SiO_2	3.62	3.24	4.84	5.55	5.03	7.29	4.59
Al_2O_3	0.40	0.28	0.66	1.22	0.45	0.44	0.33
Fe_2O_3	0.58	1.44	1.13	1.14	1.27	2.04	3.09
FeO	7.24	6.99	2.75	3.91	3.16	3.24	5.41
MgO	12.9	13.3	4.13	5.77	2.81	4.28	3.00
CaO	30.0	28.8	43.2	39.7	44.0	39.5	41.40
Na_2O	0.05	0.32	0.39	0.26	0.74	1.07	0.52
K_2O	0.01	0.04	0.42	1.05	0.14	0.27	0.22
TiO_2	0.00	0.00	0.00	0.03	0.04	0.07	0.20
P_2O_5	4.64	2.34	2.66	3.99	0.75	5.35	1.06
S	0.27	0.24	0.17	0.44	0.19	0.33	0.58
MnO	0.86	0.92	0.64	0.68	0.63	0.51	0.59
CO_2	38.70	41.30	36.80	34.80	37.60	30.90	36.80
H_2O+	0.00	0.68	0.00	0.00	0.81	0.00	0.00
H_2O-	0.34	0.17	0.44	0.39	0.40	0.23	0.42
Total	99.6	100.0	98.2	98.9	98.0	95.5	98.2
S.G.	3.00	3.00	2.84	2.89	2.76	2.92	2.92

	SOVITE						
Ref. No.	1321	1322	1323	1324	1324*	1325	1326
SiO_2	9.04	4.93	14.70	11.80	12.00	5.30	4.36
Al_2O_3	0.31	0.36	2.86	1.51	1.51	0.44	0.31
Fe_2O_3	1.64	1.94	2.24	0.63	0.71	1.13	0.33
FeO	3.58	3.66	5.82	4.74	4.66	3.33	3.49
MgO	4.75	2.38	7.42	6.01	6.01	2.76	2.50
CaO	40.3	44.6	30.20	36.1	35.8	43.5	44.8
Na_2O	1.11	0.63	0.63	0.98	0.91	0.68	0.57
K_2O	0.29	0.15	2.91	1.44	1.43	0.30	0.12
TiO_2	0.17	0.05	0.14	0.04	0.11	0.04	0.55
P_2O_5	3.31	3.52	1.63	4.47	4.18	5.26	2.44
S	0.35	0.24	0.20	0.50	0.44	0.37	0.21
MnO	0.59	0.61	0.54	0.67	0.65	0.55	0.69
CO_2	32.40	35.10	26.10	28.40	29.20	33.10	36.80
H_2O+	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H_2O-	0.30	0.36	0.55	0.38	0.39	0.40	0.19
Total	98.1	98.5	95.9	97.7	97.0	97.8	97.4
S.G.	2.90	2.89	3.00	2.91	2.91	2.89	2.86

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

* Duplicate sample.

Ref. No.	Sample No.	Ref. No.	Sample No.
1314	A2 172.9-173.2	1321	A2 609.2-609.5
1315	A2 254.5-254.7	1322	A2 662.7-663.0
1316	A2 366.7-367.1	1323	A2 708.2-708.5
1317	A2 409.3-409.6	1324	A2 731.2-731.5
1318	A2 467.3-467.6	1324*	A2-D 731.2-731.5
1319	A2 519.7-520.0	1325	A2 784.2-784.5
1320	A2 569.6-570.0	1326	A2 852.7-852.9

TABLE A-2 CONTINUED.

	SOVITE						
Ref. No.	1327	1328	1329	1330	1332	1381	1382
SiO_2	11.30	6.93	8.54	16.30	7.04	3.80	4.74
Al_2O_3	2.10	0.81	0.88	3.51	0.45	0.45	0.50
Fe_2O_3	8.50	3.44	5.96	1.78	2.04	1.62	0.99
FeO	9.48	4.33	6.16	7.49	3.99	7.99	3.49
MgO	12.20	2.68	3.94	4.52	4.89	12.60	5.26
CaO	21.9	42.6	37.9	31.9	41.4	29.0	40.0
Na_2O	0.46	0.66	0.91	1.00	0.87	0.39	0.64
K_2O	2.16	0.57	0.40	3.00	0.23	0.00	0.05
TiO_2	0.12	0.55	0.84	0.76	0.21	0.03	0.09
P_2O_5	5.75	6.83	7.85	13.8	3.29	2.60	5.25
S	0.02	0.33	0.22	0.12	0.33	0.12	0.42
MnO	0.48	0.36	0.31	0.22	0.59	0.80	0.60
CO_2	24.70	28.70	24.50	11.70	34.20	39.60	39.70
H_2O+	0.00	0.32	0.00	0.64	0.00	0.00	0.00
H_2O-	0.29	0.01	0.14	0.20	0.20	0.22	0.31
Total	99.4	99.1	98.6	96.9	99.7	99.2	97.0
S.G.	3.16	2.94	3.02	3.05	2.88	3.01	2.87

	SOVITE						
Ref. No.	1384	1385	1390	1386	1387	1387*	1388
SiO_2	11.90	7.16	8.46	5.86	6.27	6.32	5.85
Al_2O_3	2.40	1.15	0.58	0.60	0.66	0.65	0.38
Fe_2O_3	1.89	0.99	1.31	0.67	0.68	0.76	0.86
FeO	5.32	5.24	4.83	4.83	3.83	3.83	3.91
MgO	6.43	5.56	3.60	3.31	5.36	5.37	2.98
CaO	33.2	37.8	39.3	40.8	40.4	39.6	42.9
Na_2O	0.93	0.76	1.17	0.78	0.89	0.78	0.84
K_2O	1.93	0.74	0.41	0.45	0.34	0.33	0.16
TiO_2	0.10	0.33	0.06	0.06	0.06	0.13	0.01
P_2O_5	6.33	4.64	2.56	4.60	5.35	5.13	2.53
S	0.46	0.50	0.87	0.76	0.37	0.37	0.44
MnO	0.68	0.74	0.83	0.83	0.76	0.76	0.84
CO_2	26.40	31.50	32.70	32.60	33.50	33.50	35.10
H_2O+	0.21	0.00	0.09	0.20	0.00	0.00	0.06
H_2O-	0.20	0.29	0.33	0.05	0.25	0.22	0.24
Total	98.4	97.40	97.1	96.4	98.7	97.8	97.1
S.G.	2.94	2.91	2.92	2.92	2.89	2.89	2.88

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

* Duplicate sample.

Ref. No.	Sample No.	Ref. No.	Sample No.
1327	A2 918.5-919.0	1384	A137 321.9-322.1
1328	A2 926.5-926.9	1385	A137 384.3-384.6
1329	A2 942.6-943.1	1390	A137 492.2-492.4
1330	A2 977.7-977.9	1386	A137 437.7-438.0
1332	A2 998.2-998.5	1387	A137 453.1-453.3
1381	A137 227.7-227.9	1387*	A137-D 453.1-453.3
1382	A137 296.6-296.8	1388	A137 481.7-482.1

TABLE A-2 CONTINUED.

	SOVITE						
Ref. No.	**1389**	**1391**	**1392**	**1393**	**1394**	**1395**	**1396**
SiO_2	5.24	4.74	5.21	4.46	4.28	7.34	5.88
Al_2O_3	0.37	0.34	0.35	0.48	0.40	0.51	0.41
Fe_2O_3	0.78	0.27	1.21	0.85	0.00	0.68	1.19
FeO	4.66	4.08	4.49	4.33	4.58	4.41	5.16
MgO	4.65	3.11	3.23	2.80	2.99	3.62	3.28
CaO	40.0	43.5	41.7	43.4	44.1	41.0	41.5
Na_2O	0.65	0.59	0.76	0.34	0.40	0.96	0.74
K_2O	0.14	0.16	0.20	0.35	0.23	0.41	0.28
TiO_2	0.01	0.04	0.12	0.02	0.00	0.04	0.04
P_2O_5	3.48	1.61	2.57	3.26	0.90	2.35	1.18
S	0.45	0.37	0.56	0.57	0.59	0.35	0.56
MnO	0.96	0.91	0.87	0.91	0.42	0.83	0.85
CO_2	35.80	37.80	34.90	37.00	38.20	34.90	35.20
H_2O+	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H_2O-	0.27	0.32	0.34	0.30	0.19	0.28	0.29
Total	97.5	97.8	96.5	99.1	98.1	97.7	96.6
S.G.	2.90	2.86	2.91	2.88	2.85	2.89	2.99

	SOVITE						
Ref. No.	**1397**	**1398**	**1399**	**1400**	**1401**	**1406**	**1407**
SiO_2	3.69	3.87	5.32	8.38	3.84	9.16	5.60
Al_2O_3	0.32	0.29	0.54	0.98	0.55	1.05	0.39
Fe_2O_3	0.25	0.70	3.20	0.82	0.93	4.59	2.16
FeO	3.58	8.32	6.66	4.16	7.32	5.41	3.08
MgO	3.06	11.30	3.80	4.02	8.69	3.05	2.21
CaO	44.3	30.9	38.6	40.4	33.7	39.6	44.3
Na_2O	0.35	0.63	0.47	0.97	0.40	0.87	0.63
K_2O	0.10	0.01	0.37	0.63	0.14	0.68	0.14
TiO_2	0.00	0.00	0.18	0.06	0.02	0.79	0.10
P_2O_5	3.66	5.66	3.04	6.82	2.71	6.03	3.01
S	0.19	0.09	0.45	0.44	0.12	0.28	0.33
MnO	0.85	1.14	0.74	0.63	0.96	0.35	0.54
CO_2	37.20	36.80	33.50	28.20	33.70	26.30	34.00
H_2O+	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H_2O-	0.22	0.30	0.41	0.24	0.35	0.38	0.27
Total	97.8	100.0	97.3	96.7	98.4	98.5	96.8
S.G.	2.85	3.04	2.96	2.92	2.96	2.98	2.86

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1389	A137 488.0-488.3	1397	A137 617.8-618.1
1391	A137 516.2-516.5	1398	A137 642.3-642.6
1392	A137 531.5-531.9	1399	A137 698.0-698.4
1393	A137 559.3-559.6	1400	A137 704.1-704.3
1394	A137 578.0-578.3	1401	A137 718.8-719.3
1395	A137 589.1-589.3	1406	A147 353.0-353.4
1396	A137 609.3-609.6	1407	A147 373.4-374.6

TABLE A-2 CONTINUED.

	SOVITE						
Ref. No.	1408	1409	1410	1411	1412	1413	1414
SiO_2	6.77	7.41	10.6	4.95	6.97	5.81	7.90
Al_2O_3	0.49	0.50	0.38	0.25	0.40	0.45	0.63
Fe_2O_3	1.34	1.04	1.70	0.60	0.69	1.40	2.75
FeO	3.99	3.58	5.91	3.08	3.74	3.41	4.41
MgO	2.44	2.79	2.94	1.92	3.86	3.60	2.71
CaO	43.0	42.5	39.4	47.4	41.5	45.7	40.0
Na_2O	0.75	0.86	1.58	0.58	0.73	0.75	0.84
K_2O	0.38	0.44	0.30	0.14	0.32	0.32	0.46
TiO_2	0.07	0.09	0.22	0.02	0.00	0.07	0.36
P_2O_5	2.81	4.93	7.97	0.78	5.23	2.66	7.26
S	0.60	0.61	0.56	0.25	0.96	0.38	0.99
MnO	0.55	0.51	0.44	0.58	0.57	0.60	0.50
CO_2	33.30	31.10	23.90	38.40	32.40	35.70	26.80
H_2O+	0.06	0.00	0.00	0.00	0.00	0.00	0.11
H_2O-	0.17	0.20	0.30	0.24	0.15	0.41	0.15
Total	96.7	96.6	96.2	99.2	97.5	101.0	95.9
S.G.	2.87	2.88	3.24	2.81	2.89	2.87	2.95

	SOVITE						
Ref. No.	1358	1359	1360	1361	1362	1363	1364
SiO_2	5.96	3.36	3.86	3.48	5.88	6.93	4.62
Al_2O_3	0.49	0.41	0.53	0.33	0.53	0.57	0.63
Fe_2O_3	0.80	1.42	1.87	0.05	2.12	2.58	5.01
FeO	3.24	7.99	7.24	8.32	4.58	4.58	5.57
MgO	3.10	13.10	12.40	13.00	3.17	3.05	3.51
CaO	43.6	28.5	29.0	28.5	41.7	39.90	39.6
Na_2O	0.81	0.37	0.46	0.37	0.72	0.84	0.48
K_2O	0.11	0.11	0.14	0.02	0.33	0.38	0.28
TiO_2	0.01	0.02	0.07	0.00	0.09	0.16	0.26
P_2O_5	3.68	2.24	4.63	3.28	2.91	2.66	4.87
S	0.41	0.21	0.47	0.17	0.73	0.52	0.73
MnO	0.49	0.92	0.89	0.86	0.69	0.69	0.64
CO_2	35.30	40.40	36.00	39.80	33.80	33.70	30.30
H_2O+	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H_2O-	0.17	0.25	0.28	0.22	0.18	0.26	0.21
Total	98.2	99.3	97.8	98.4	97.4	96.8	96.7
S.G.	3.01	3.01	3.03	3.01	2.92	2.92	2.98

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1408	A147 405.7-406.1	1358	A8 266.3-266.8
1409	A147 412.9-413.3	1359	A8 309.3-309.6
1410	A147 461.8-462.2	1360	A8 323.3-323.6
1411	A147 473.8-474.2	1361	A8 363.6-364.0
1412	A147 501.6-502.2	1362	A8 407.7-408.3
1413	A147 523.2-523.6	1363	A8 418.5-418.9
1414	A147 532.5-532.9	1364	A8 455.9-456.3

TABLE A-2 CONTINUED.

	SOVITE						
Ref. No.	**1365**	**1366**	**1366A**	**1366A***	**1367**	**1369**	**1370**
SiO_2	5.01	3.88	6.23	6.02	2.74	2.58	8.53
Al_2O_3	0.46	0.34	0.98	0.97	0.22	0.38	1.42
Fe_2O_3	0.58	1.27	2.47	2.49	0.16	0.00	0.98
FeO	3.99	2.33	3.33	3.24	2.00	2.08	3.49
MgO	3.06	3.11	6.06	5.83	3.64	2.28	4.68
CaO	43.9	47.1	40.3	40.2	47.2	48.4	38.5
Na_2O	0.54	0.24	0.26	0.17	0.17	0.18	0.49
K_2O	0.23	0.22	0.91	0.91	0.06	0.19	1.19
TiO_2	0.02	0.03	0.01	0.01	0.00	0.00	0.02
P_2O_5	2.74	3.91	4.10	4.29	0.20	4.63	3.60
S	0.57	0.19	0.76	0.77	0.16	0.20	0.44
MnO	0.72	0.30	0.45	0.44	0.46	0.43	0.40
CO_2	36.60	36.60	33.80	33.60	42.20	38.10	32.60
H_2O+	0.00	0.04	0.00	0.00	0.00	0.00	0.04
H_2O-	0.27	0.08	0.19	0.21	0.25	0.20	0.27
Total	98.7	99.6	99.8	99.1	99.5	99.6	96.7
S.G.	2.87	2.85	2.89	2.89	2.80	2.82	2.87

	SOVITE						
Ref. No.	**1371**	**1372**	**1373**	**1374**	**1375**	**1376**	**1377**
SiO_2	3.80	4.89	7.82	6.04	3.91	4.86	5.53
Al_2O_3	0.24	0.22	0.49	0.85	0.74	0.38	0.49
Fe_2O_3	3.28	4.29	2.25	1.46	0.14	2.00	4.21
FeO	3.74	4.83	3.41	3.33	3.08	3.66	4.91
MgO	3.46	2.92	4.22	3.18	2.87	3.72	4.22
CaO	43.8	42.6	39.9	41.5	45.0	42.8	40.3
Na_2O	0.40	0.51	0.82	0.31	0.10	0.43	0.53
K_2O	0.06	0.08	0.47	0.74	0.60	0.27	0.36
TiO_2	0.01	0.19	0.03	0.02	0.00	0.11	0.20
P_2O_5	1.98	2.05	6.81	5.40	5.58	3.39	3.31
S	0.85	0.12	0.62	0.37	0.60	0.31	0.40
MnO	0.44	0.38	0.34	0.34	0.31	0.41	0.46
CO_2	36.50	34.20	29.80	32.50	34.00	35.0	33.60
H_2O+	0.00	0.00	0.00	0.01	0.01	0.00	0.18
H_2O-	0.22	0.35	0.21	0.16	0.22	0.21	0.15
Total	98.8	97.6	97.2	96.2	97.2	97.6	98.8
S.G.	2.89	2.93	2.92	2.91	2.85	2.90	2.89

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

* Duplicate sample.

Ref. No.	Sample No.	Ref. No.	Sample No.
1365	A8 476.2-476.6	1371	A8 932.8-933.3
1366	A8 732.1-732.3	1372	A8 939.4-939.8
1366A	A8 740.6-741.0	1373	A8 977.6-978.1
1366A*	A8-D 740.6-741.0	1374	A8 998.7-999.1
1367	A8 832.2-832.7	1375	A8 1036.5-1037.0
1369	A8 880.8-881.2	1376	A8 1081.3-1081.6
1370	A8 889.0-889.4	1377	A8 1098.4-1098.8

TABLE A-2 CONTINUED.

	SOVITE						
Ref. No.	1378	1379	1380	1337	1339	1340	1341
SiO_2	7.43	6.87	3.20	3.14	4.66	3.72	3.45
Al_2O_3	0.53	0.42	0.28	0.54	0.46	0.40	0.27
Fe_2O_3	3.73	3.52	0.32	0.00	1.25	0.44	0.30
FeO	4.33	4.24	6.16	2.50	4.59	4.49	2.91
MgO	4.51	4.24	14.80	2.97	12.10	12.80	3.00
CaO	39.8	40.4	29.1	44.8	32.7	31.8	46.2
Na_2O	0.76	0.67	0.32	0.23	0.58	0.56	0.39
K_2O	0.46	0.32	0.02	0.38	0.07	0.08	0.08
TiO_2	0.14	0.22	0.00	0.00	0.00	0.04	0.00
P_2O_5	4.39	4.61	3.12	3.53	9.10	3.89	0.58
S	0.21	0.31	0.35	0.14	0.13	0.21	0.20
MnO	0.42	0.41	0.67	0.58	0.60	0.65	0.73
CO_2	31.40	31.10	40.80	37.20	32.70	37.80	40.70
H_2O+	0.00	0.03	0.00	0.00	0.00	0.00	0.00
H_2O-	0.18	0.14	0.27	0.17	0.12	0.18	0.22
Total	98.3	97.5	99.1	96.2	99.1	97.0	99.1
S.G.	2.93	2.94	2.98	2.84	3.00	2.89	2.82

	SOVITE						
Ref. No.	1342	1343	1344	1345	1346	1346*	1348
SiO_2	5.27	5.54	6.25	8.87	6.07	6.02	10.2
Al_2O_3	0.29	0.57	0.43	0.72	0.70	0.70	1.01
Fe_2O_3	0.31	0.88	1.62	2.59	3.59	3.66	3.63
FeO	2.91	3.08	4.49	4.41	4.08	4.08	4.99
MgO	2.89	2.83	2.75	4.37	3.05	3.04	2.91
CaO	43.9	44.0	41.3	38.6	42.7	42.0	39.6
Na_2O	0.76	0.45	0.79	0.96	0.44	0.41	1.10
K_2O	0.07	0.48	0.29	0.56	0.51	0.50	0.64
TiO_2	0.00	0.02	0.79	0.54	0.49	0.59	0.43
P_2O_5	3.24	4.43	3.11	7.90	5.22	4.91	6.70
S	0.32	0.20	0.74	0.71	0.32	0.31	0.33
MnO	0.58	0.58	0.62	0.46	0.34	0.34	0.33
CO_2	37.00	34.60	33.20	26.20	30.60	31.00	26.90
H_2O+	0.00	0.00	0.04	0.12	0.00	0.00	0.00
H_2O-	0.16	0.24	0.21	0.13	0.14	0.16	0.29
Total	97.7	97.9	96.6	97.1	98.2	97.7	99.1
S.G.	2.84	2.86	2.91	2.98	2.93	2.93	2.97

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

* Duplicate sample.

Ref. No.	Sample No.	Ref. No.	Sample No.
1378	A8 1137.8-1138.3	1342	AB3 578.2-578.4
1379	A8 1148.4-1148.7	1343	AB3 594.3-594.5
1380	A8 1197.6-1198.0	1344	AB3 628.2-628.4
1337	AB3 432.2-432.4	1345	AB3 643.2-643.4
1339	AB3 472.2-472.4	1346	AB3 698.8-699.0
1340	AB3 485.8-486.0	1346*	AB3-D 698.8-699.0
1341	AB3 538.2-538.4	1348	AB3 737.3-738.1

TABLE A-2 CONTINUED.

	SOVITE			HORNBLENDITE			
Ref. No.	1349	1350	1347	1402	1403	1351	1356
SiO_2	9.04	9.20	8.29	31.8	32.7	40.6	35.9
Al_2O_3	1.06	1.00	0.81	8.91	7.65	11.6	9.49
Fe_2O_3	4.55	3.39	4.15	5.13	2.99	2.40	4.80
FeO	5.99	4.99	4.83	8.57	8.65	7.74	9.82
MgO	2.50	3.06	2.27	11.60	11.30	14.40	9.15
CaO	39.5	40.1	41.4	16.50	18.80	12.30	17.10
Na_2O	0.76	0.74	0.89	1.97	1.84	2.44	2.10
K_2O	0.90	0.73	0.45	0.90	0.79	1.81	1.28
TiO_2	0.58	0.71	0.43	4.34	2.76	3.80	2.90
P_2O_5	6.98	6.95	5.31	4.44	6.23	0.06	3.93
S	0.32	0.30	0.44	0.62	0.63	0.02	0.58
MnO	0.31	0.32	0.35	0.18	0.15	0.12	0.19
CO_2	25.80	26.60	29.00	1.53	2.67	1.02	1.54
H_2O+	0.10	0.05	0.25	0.90	0.77	0.42	0.62
H_2O-	0.16	0.30	0.25	0.23	0.33	0.17	0.17
Total	98.6	98.4	99.9	97.6	98.3	98.9	99.6
S.G.	3.00	2.97	2.96	3.23	3.14	3.19	3.25

	PYROXENITE					
Ref. No.	1335	1335*	1336	1404	1404*	1405
SiO_2	36.7	36.8	32.7	38.0	37.60	39.8
Al_2O_3	3.35	3.21	3.56	7.94	7.78	5.51
Fe_2O_3	7.79	8.18	7.48	4.18	4.48	5.07
FeO	7.57	7.49	8.57	8.57	8.57	7.32
MgO	12.90	12.60	10.90	13.50	13.70	13.30
CaO	19.90	19.7	21.10	15.20	15.10	18.70
Na_2O	1.20	1.00	1.16	1.86	1.77	1.26
K_2O	0.38	0.37	0.38	1.00	1.05	0.62
TiO_2	2.80	2.88	3.92	3.33	3.25	2.89
P_2O_5	0.21	0.19	1.63	0.36	0.34	0.45
S	1.21	1.20	0.70	0.33	0.34	0.30
MnO	0.19	0.18	0.21	0.21	0.21	0.16
CO_2	5.53	5.56	6.00	3.11	3.23	3.55
H_2O+	0.22	0.24	0.10	0.76	0.84	0.43
H_2O-	0.24	0.22	0.23	0.24	0.26	0.20
Total	100.2	99.8	98.6	98.6	98.5	99.6
S.G.	3.29	3.29	3.32	3.16	3.16	3.26

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

* Duplicate sample.

Ref. No.	Sample No.	Ref. No.	Sample No.
1349	AB3 792.3-793.0	1335	A2 1122.8-1123.5
1350	AB3 847.0-847.6	1335*	A2-D 1122.8-1123.5
1347	AB3 701.8-702.5	1336	A2 1183.0-1183.8
1402	A147 230.7-231.5	1404	A147 250.9-251.8
1403	A147 246.0-246.7	1404*	A147-D 250.9-251.8
1351	AB3 984.0-984.6	1405	A147 270.2-271.6
1356	AB3 1142.8-1143.6		

TABLE A-2 CONTINUED.

	PYROXENITE					
Ref. No.	1352	1353	1354	1354*	1355	1357
SiO_2	35.6	24.10	36.1	36.1	32.2	41.8
Al_2O_3	7.70	5.23	5.52	5.44	5.12	4.94
Fe_2O_3	5.00	5.50	4.42	4.42	5.40	2.85
FeO	9.98	12.10	7.99	7.90	9.73	7.07
MgO	10.70	7.76	10.70	10.80	9.59	8.66
CaO	17.90	21.70	20.40	20.30	20.90	24.00
Na_2O	1.68	0.97	0.93	0.91	0.81	1.15
K_2O	0.98	0.65	0.92	0.93	1.22	0.13
TiO_2	4.11	7.24	4.18	4.13	4.41	1.86
P_2O_5	4.37	10.70	5.38	5.35	7.22	4.52
S	0.54	0.81	0.40	0.47	0.54	0.59
MnO	0.17	0.20	0.15	0.15	0.18	0.17
CO_2	0.84	0.70	0.70	0.61	0.92	1.28
H_2O+	0.18	0.11	0.44	0.35	0.19	0.35
H_2O-	0.10	0.20	0.22	0.20	0.25	0.40
Total	99.8	98.0	98.4	98.0	98.7	99.7
S.G.	3.35	3.45	3.33	3.33	3.35	3.30

	SILICOCARBONATITE					
Ref. No.	1331	1383	1368	1338	1333	1334
SiO_2	23.60	32.00	16.3	23.6	27.5	28.1
Al_2O_3	6.60	6.50	4.26	6.81	8.37	4.13
Fe_2O_3	1.90	3.00	0.83	1.21	1.90	9.70
FeO	1.06	9.57	3.99	8.90	9.24	10.60
MgO	5.78	13.00	14.0	11.10	14.30	10.20
CaO	21.4	12.1	25.5	18.5	12.50	17.10
Na_2O	0.94	1.57	0.17	0.08	0.84	2.77
K_2O	4.71	5.95	3.87	5.91	5.93	0.76
TiO_2	1.06	0.56	0.05	0.72	3.13	4.18
P_2O_5	4.24	2.45	6.94	1.15	0.66	1.58
S	0.04	0.05	0.01	0.30	0.18	0.20
MnO	0.27	0.32	0.31	0.32	0.27	0.30
CO_2	13.50	10.93	21.30	16.20	9.96	8.20
H_2O+	1.09	0.63	0.20	1.13	0.00	0.34
H_2O-	0.11	0.20	0.59	0.26	2.27	0.27
Total	95.8	98.8	98.3	96.2	95.1	98.4
S.G.	2.95	3.01	3.38	2.91	2.94	3.25

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

* Duplicate sample.

Ref. No.	Sample No.	Ref. No.	Sample No.
1352	AB3 1037.6-1038.7	1331	A2 988.1-988.7
1353	AB3 1040.2-1041.1	1383	A137 318.6-318.8
1354	AB3 1075.5-1076.1	1368	A8 843.6-844.0
1354*	AB3-D 1075.5-1076.1	1338	AB3 443.2-443.4
1355	AB3 1090.8-1091.6	1333	A2 1059.0-1059.7
1357	AB3 1178.7-1179.2	1334	A2 1110.9-1111.6

TABLE A-3. TRACE ELEMENT ANALYSES (PPM) OF WHOLE-ROCK SAMPLES FROM THE ARGOR CARBONATITE COMPLEX.

	SOVITE						
Ref. No.	1314	1315	1316	1317	1318	1319	1320
Ag		<1	28		<1	<1	2
Au							
As							
Ba	70	60	480	360	680	320	510
Be		<1	<1		<1	<1	1
Bi							
Co	9	6	8	13	8	9	16
Cr	<5	<5	10	<5	<5	<5	<5
Cu	10	6	10	7	8	8	8
Ga		23	23		3	3	15
Hg							
Li	9	6	7	7	7	6	8
Mn							
Mo	<3	<3	<3	<3	<3	<3	<3
Nb	5000	3500	5000	1.2%	1.0%	1.7%	1000
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	<10	<10	<10	<10	<10	<10	<10
Rb	<10	<10	20	30	<10	<10	<10
Sb							
Sc	<5	<5	8	<5	9	10	10
Sn		5	58		2	8	9
Sr	9000	9000	1.7%	1.4%	2.0%	1.0%	1.1%
Ti							
V	10	10	15	3	35	40	90
Y	70	50	150	150	150	100	100
Zn	420	55	34	42	30	32	48
Zr	100	20	7	40	20	10	20
La	250	150	400	400	350	450	350
Nd	150	100	170	170	140	200	140
Ce	300	220	400	360	340	440	340
Yb	2	1	10	9	10	8	8
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	0.1%	0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1314	A2 172.9-173.2	1318	A2 467.3-467.6
1315	A2 254.5-254.7	1319	A2 519.7-520.0
1316	A2 366.7-367.1	1320	A2 569.6-570.0
1317	A2 409.3-409.6		

TABLE A-3 CONTINUED.

	SOVITE						
Ref. No.	1321	1322	1323	1324	1324*	1325	1326
Ag		2	1	2		<1	<1
Au							
As							
Ba	320	490	370	370	380	410	490
Be		1	2	2		<1	1
Bi							
Co	10	6	11	12	12	8	9
Cr	<5	<5	33	11	10	<5	<5
Cu	8	8	8	8	8	9	9
Ga		19	120	140		8	7
Hg							
Li	6	7	11	8	12	6	7
Mn							
Mo	<3	<3	<3	<3	<3†	<3	<3
Nb	2000	4000	1500	4500	4000	1.0%	5000
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	<10	<10	10	15	18	14	<10
Rb	<10	<10	80	40	50	10	<10
Sb							
Sc	20	7	15	15	15	8	5
Sn		12	1	8	4	6	
Sr	8000	1.0%	5000	8000	7500	7000	9000
Ti							
V	25	60	45	15	15	30	20
Y	100	150	90	150	150	150	150
Zn	40	40	88	52	51	33	36
Zr	15	10	1500	20	25	25	40
La	400	400	250	400	350	450	400
Nd	150	170	120	170	160	200	170
Ce	340	380	280	380	340	440	380
Yb	8	9	6	8	9	9	9
Ta	<0.1%	0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

* Duplicate sample.
† Zr interference.

Ref. No.	Sample No.	Ref. No.	Sample No.
1321	A2 609.2-609.5	1324*	A2-D 731.2-731.5
1322	A2 662.7-663.0	1325	A2 784.2-784.5
1323	A2 708.2-708.5	1326	A2 852.7-852.9
1324	A2 731.2-731.5		

TABLE A-3 CONTINUED.

	SOVITE						
Ref. No.	**1327**	**1328**	**1329**	**1330**	**1332**	**1381**	**1382**
Ag	3			1	2	<1	5
Au							
As							
Ba	80	420	290	420	270	70	660
Be	3			24	2	<1	1
Bi							
Co	14	14	13	16	11	9	29
Cr	7	<5	<5	<5	<5	<5	<5
Cu	<6	40	21	16	7	8	54
Ga	200			130	16	7	5
Hg							
Li	12	6	4	6	6	5	6
Mn							
Mo	<3	<3	<3	<3	<3	30	<3
Nb	1500	150	250	500	3500	6000	9000
Ni	<5	<5	<5	<5	<5	<5	13
Pb	<10	<10	34	84	<10	<10	<10
RB	90	10	<10	100	<10	<10	10
Sb							
Sc	4	5	6	5	9	7	6
Sn	10			20	7	8	7
Sr	4000	6000	4000	5000	6000	3000	4000
Ti							
V	20	150	250	60	25	40	35
Y	60	150	100	150	150	40	100
Zn	60	76	186	136	38	51	109
Zr	350	500	350	900	20	45	10
La	250	400	350	500	350	150	450
Nd	180	190	200	280	200	100	180
Ce	340	400	420	560	420	220	420
Yb	2	9	7	6	8	1	8
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1327	A2 918.5-919.0	1332	A2 998.2-998.5
1328	A2 926.5-926.9	1381	A137 227.7-227.9
1329	A2 942.6-943.1	1382	A137 296.6-296.8
1330	A2 977.7-977.9		

TABLE A-3 CONTINUED.

	SOVITE						
Ref. No.	1384	1385	1390	1386	1387	1387*	1388
Ag	2	4	<1	<1	<1		<1
Au							
As							
Ba	850	180	370	400	240	240	370
Be	<1	1	<1	<1	1		1
Bi							
Co	12	12	17	15	7	7	8
Cr	9	8	<5	<5	<5	<5	<5
Cu	19	9	10	12	9	6	9
Ga	130	58	5	6	22		7
Hg							
Li	14	10	12	10	10	10	12
Mn							
Mo	<3	<3	<3	<3	<3	<3†	<3
Nb	3000	7500	1.0%	1.5%	9000	9000	7000
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	60	30	10	20	10	<10	<10
Rb	60	30	10	20	10	10	<10
Sb							
Sc	6	4	7	7	7	6	6
Sn	26	10	7	6	15		10
Sr	2500	4000	9000	1.6%	7000	7000	1.8%
Tl							
V	40	40	30	30	20	20	30
Y	100	90	100	150	150	150	150
Zn	190	50	40	37	36	33	32
Zr	40	15	20	20	15	15	9
La	800	300	300	450	500	500	300
Nd	260	170	170	190	210	210	170
Ce	680	380	360	420	440	440	360
Yb	8	7	10	10	10	10	10
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

* Duplicate sample.
† Zr interference.

Ref. No.	Sample No.	Ref. No.	Sample No.
1384	A137 321.9-322.1	1387	A137 453.1-453.3
1385	A137 384.3-384.6	1387*	A137-D 453.1-453.3
1390	A137 492.2-492.4	1388	A137 481.7-482.1
1386	A137 437.7-438.0		

TABLE A-3 CONTINUED.

	SOVITE						
Ref. No.	**1389**	**1391**	**1392**	**1393**	**1394**	**1395**	**1396**
Ag	<1	<1	<1	4	3	<1	<1
Au							
As							
Ba	320	410	370	400	370	350	370
Be	1	1	<1	27	10	21	<1
Bi							
Co	8	7	11	10	11	7	11
Cr	<5	<5	<5	<5	5	<5	<5
Cu	8	11	10	9	12	9	10
Ga	11	7	2	27	10	21	3
Hg							
Li	10	11	11	11	10	12	12
Mn							
Mo	<3	<3	<3	<3	<3	<3	<3
Nb	5000	7000	1.3%	3000	4000	7000	1.0%
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	<10	18	<10	18	17	<10	<10
Rb	<10	<10	<10	10	<10	10	<10
Sb							
Sc	7	7	8	<5	<5	<5	<5
Sn	6	12	6	8	6	8	4
Sr	1.4%	1.9%	1.7%	1.6%	2.0%	1.5%	1.8%
Ti							
V	20	15	45	25	15	40	70
Y	150	150	150	150	150	100	100
Zn	33	32	37	48	71	40	42
Zr	10	9	35	9	7	10	15
La	400	400	400	500	350	350	300
Nd	170	150	160	170	150	160	180
Ce	340	340	380	380	320	380	340
Yb	10	10	10	10	10	10	9
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1389	A137 488.0-488.3	1394	A137 578.0-578.3
1391	A137 516.2-516.5	1395	A137 589.1-589.3
1392	A137 531.5-531.9	1396	A137 609.3-609.6
1393	A137 559.3-559.6		

TABLE A-3 CONTINUED.

	SOVITE						
Ref. No.	**1397**	**1398**	**1399**	**1400**	**1401**	**1406**	**1407**
Ag	<1	1	2	2	<1	2	<1
Au							
As							
Ba	340	80	310	410	150	540	450
Be	<1	1	1		1	2	2
Bi							
Co	<5	6	10	8	7	14	9
Cr	<5	<5	<5	<5	<5	<5	<5
Cu	9	8	9	9	8	26	11
Ga	7	6	37	36	10	36	17
Hg							
Li	10	6	10	10	7	6	7
Mn							
Mo	<3	<3	<3	<3	<3	<3	<3
Nb	3500	5000	6000	8000	7000	200	3500
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	<10	<10	15	12	<10	14	16
Rb	<10	<10	10	20	<10	20	<10
Sb							
Sc	<5	<5	<5	<5	<5	6	25†
Sn	4	9	13	15	4	26	17
Sr	1.8%	7000	1.6%	1.5%	1.0%	5000	7000
Ti							
V	15	15	150	20	90	150	60
Y	150	70	100	150	90	150	150
Zn	30	50	65	44	51	98	38
Zr	8	25	200	15	45	800	4000
La	350	400	350	600	250	350	400
Nd	170	160	160	240	120	230	220
Ce	380	380	360	540	280	380	400
Yb	10	2	9	10	6	8	10
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

† Zr interference.

Ref. No.	Sample No.	Ref. No.	Sample No.
1397	A137 617.8-618.1	1401	A137 718.8-719.3
1398	A137 642.3-642.6	1406	A147 353.0-353.4
1399	A137 698.0-698.4	1407	A147 373.4-374.6
1400	A137 704.1-704.3		

TABLE A-3 CONTINUED.

	SOVITE						
Ref. No.	**1408**	**1409**	**1410**	**1411**	**1412**	**1413**	**1414**
Ag	2	2	<1	<1	2	2	<1
Au							
As							
Ba	560	370	360	460	420	440	360
Be	2	<1	<1	<1	<1	<1	<1
Bi							
Co	12	15	11	7	20	9	21
Cr	5	5	5	<5	<5	<5	<5
Cu	8	10	9	8	8	8	9
Ga	30	34	3	8	28	22	8
Hg							
Li	8	8	7	8	7	8	7
Mn							
Mo	<3	<3	<3	<3	<3	<3	<3
Nb	6000	7000	1.4%	1500	5000	7000	1.2%
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	<10	11	27	<10	18	<10	44
Rb	10	10	<10	<10	10	10	20
Sb							
Sc	8	8	10	6	20†	10	9
Sn	20	19	6	4	5	6	6
Sr	9000	7000	5000	1.0%	7000	8000	6000
Ti							
V	30	30	70	20	<10	30	60
Y	100	150	150	150	150	150	150
Zn	45	42	62	34	28	34	53
Zr	20	40	150	10	2500	30	90
La	350	450	500	300	450	400	500
Nd	190	220	280	160	240	220	280
Ce	360	400	520	320	420	400	500
Yb	9	10	9	10	10	10	10
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

† Zr interference.

Ref. No.	Sample No.	Ref. No.	Sample No.
1408	A147 405.7-406.1	1412	A147 501.6-502.2
1409	A147 412.9-413.3	1413	A147 523.2-523.6
1410	A147 461.8-462.2	1414	A147 532.5-532.9
1411	A147 473.8-474.2		

TABLE A-3 CONTINUED.

	SOVITE						
Ref. No.	1358	1359	1360	1361	1362	1363	1364
Ag	3	<1	<1	<1	<1	2	6
Au							
As							
Ba	380	80	60	80	350	470	420
Be	2	<1	<1	<1	1	1	1
Bi							
Co	12	13	14	10	16	12	17
Cr	<5	<5	<5	<5	<5	<5	<5
Cu	12	6	8	6	8	10	8
Ga	10	9	17	5	29	30	42
Hg							
Li	6	4	4	6	10	10	12
Mn							
Mo	<3	<3	<3	<3	<3	<3	<3
Nb	7000	3500	7000	2500	7000	7000	7000
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	25	13	98	<10	12	18	27
Rb	<10	<10	<10	<10	10	10	10
Sb							
Sc	10	5	5	7	8	10	4
Sn	28	5	11	10	18	27	30
Sr	6000	4000	3000	5000	7000	8000	5000
Ti							
V	25	10	25	15	90	100	200
Y	150	40	70	50	150	150	150
Zn	62	74	150	54	43	48	460
Zr	70	20	600	30	25	30	200
La	450	150	450	400	400	350	500
Nd	230	110	200	170	200	180	260
Ce	440	200	400	340	360	340	480
Yb	10	1	3	1	9	10	10
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1358	A8 266.3-266.8	1362	A8 407.7-408.3
1359	A8 309.3-309.6	1363	A8 418.5-418.9
1360	A8 323.3-323.6	1364	A8 455.9-456.3
1361	A8 363.6-364.0		

TABLE A-3 CONTINUED.

	SOVITE						
Ref. No.	**1365**	**1366**	**1366A**	**1366A***	**1367**	**1369**	**1370**
Ag	<1	<1	<1		<1	<1	3
Au							
As							
Ba	460	590	460	420	580	620	550
Be	<1	2	2		1	1	3
Bi							
Co	10	6	25	26	<5	5	10
Cr	<5	<5	<5	<5	<5	<5	<5
Cu	7	8	10	8	8	8	8
Ga	30	27	57		13	19	125
Hg							
Li	15	10	9	9	10	10	11
Mn							
Mo	<3	<3	<3	<3†	<3	<3	<3
Nb	6000	3000	1500	1500	<30	5000	1000
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	16	69	33	35	<10	14	16
Rb	<10	10	30	30	<10	10	40
Sb							
Sc	6	8	<5	<5	<5	<5	20†
Sn	7	8	4		<1	1	3
Sr	8000	7000	4000	4000	8000	9000	7000
Ti							
V	15	45	10	10	15	<10	<10
Y	150	100	150	150	150	150	150
Zn	35	36	75	76	19	18	45
Zr	300	1000	150	200	<10	150	3000
La	350	350	450	450	300	300	350
Nd	210	210	250	290	170	250	220
Ce	380	360	400	400	320	440	400
Yb	10	8	10	10	10	9	10
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

* Duplicate sample.
† Zr interference.

Ref. No.	Sample No.	Ref. No.	Sample No.
1365	A8 476.2-476.6	1367	A8 832.2-832.7
1366	A8 732.1-732.3	1369	A8 880.8-881.2
1366A	A8 740.6-741.0	1370	A8 889.0-889.4
1366A*	A8-D 740.6-741.0		

TABLE A-3 CONTINUED.

	SOVITE						
Ref. No.	**1371**	**1372**	**1373**	**1374**	**1375**	**1376**	**1377**
Ag	2	1	1	2	2	<1	<1
Au							
As							
Ba	580	550	500	570	590	510	440
Be	2	1	3	1	1	1	1
Bi							
Co	30	5	18	14	13	8	12
Cr	<5	<5	<5	5	<5	<5	<5
Cu	8	8	10	11	14	8	8
Ga	9	9	55	64	53	32	37
Hg							
Li	10	10	9	10	10	10	9
Mn							
Mo	<3	<3	<3	<3	<3	<3	<3
Nb	2500	1500	2000	500	2500	900	100
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	40	20	120	52	58	40	<10
Rb	<10	<10	30	30	20	10	20
Sb							
Sc	<5	<5	<5	50†	<5	4	<5
Sn	6	8	5	25	5	4	5
Sr	9000	8000	6000	8000	8000	8000	8000
Ti							
V	<10	70	10	10	<10	50	70
Y	150	150	150	150	150	150	100
Zn	52	54	40	42	32	56	52
Zr	20	30	250	1.0%	15	20	25
La	350	250	450	350	450	350	300
Nd	230	200	280	260	250	200	210
Ce	380	344	460	440	440	360	380
Yb	10	10	10	15	10	9	9
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

† Zr interference.

Ref. No.	Sample No.	Ref. No.	Sample No.
1371	A8 932.8-933.3	1375	A8 1036.5-1037.0
1372	A8 939.4-939.8	1376	A8 1081.3-1081.6
1373	A8 977.6-978.1	1377	A8 1098.4-1098.8
1374	A8 998.7-999.1		

TABLE A-3 CONTINUED.

	SOVITE						
Ref. No.	**1378**	**1379**	**1380**	**1337**	**1339**	**1340**	**1341**
Ag	<1	<1	<1	<1	<1		<1
Au							
As							
Ba	470	480	80	570	110	80	480
Be	1	1	<1	<1	<1		<1
Bi							
Co	8	11	5	<5	7	8	6
Cr	<5	<5	<5	5	<5	<5	<5
Cu	8	10	5	14	8	7	<5
Ga	26	29	3	34	8		7
Hg							
Li	10	9	6	10	5	5	9
Mn							
Mo	<3	<3	<3	<3	<3	<3	<3
Nb	100	600	500	8000	4500	1.2%	1500
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	<10	15	<10	44	<10	22	<10
Rb	20	10	<10	20	<10	<10	<10
Sb							
Sc	<5	8	10	<5	10	10	9
Sn	<1	3	30	3	2		2
Sr	6000	7000	4000	8000	3500	1000	1.3%
Ti							
V	60	100	<10	<10	10	15	15
Y	150	150	50	150	150	150	150
Zn	58	68	38	28	39	60	20
Zr	200	1000	10	200	40	100	7
La	300	350	100	350	450	400	300
Nd	170	190	100	190	280	220	140
Ce	360	360	180	400	500	480	360
Yb	9	9	1	15	6	9	10
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1378	A8 1137.8-1138.3	1339	AB3 472.2-472.4
1379	A8 1148.4-1148.7	1340	AB3 485.8-486.0
1380	A8 1197.6-1198.0	1341	AB3 538.2-538.4
1337	AB3 432.2-432.4		

TABLE A-3 CONTINUED.

	SOVITE						
Ref. No.	1342	1343	1344	1345	1346	1346*	1348
Ag	<1	<1	<1	<1	2		1
Au							
As							
Ba	460	460	460	360	580	610	520
Be	1	1	<1	1	1		7
Bi							
Co	5	<5	12	22	12	17	10
Cr	<5	<5	<5	<5	<5	<5	<5
Cu	6	5	6	6	16	16	23
Ga	7	53	8	13	20		36
Hg							
Li	10	10	10	12	8	8	10
Mn							
Mo	<3	<3	<3	<3	<3	<3†	<3
Nb	4500	2500	1.1%	1.0%	200	150	700
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	<10	<10	<10	16	<10	<10	65
Rb	<10	20	10	20	10	10	20
Sb							
Sc	10	6	6	10	9	7	9
Sn	3	1	5	7	<1		10
Sr	1.3%	1.3%	9000	7000	7000	6000	8000
Ti							
V	15	20	40	45	150	150	150
Y	150	150	150	150	150	150	100
Zn	26	34	40	38	74	78	84
Zr	10	9	20	800	1000	900	800
La	350	400	300	500	350	350	350
Nd	180	200	180	260	200	190	210
Ce	400	440	400	520	400	400	440
Yb	10	10	10	9	10	10	10
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

* Duplicate sample.
† Zr interference.

Ref. No.	Sample No.
1342	AB3 578.2-578.4
1343	AB3 594.3-594.5
1344	AB3 628.2-628.4
1345	AB3 643.2-643.4
1346	AB3 698.8-699.0
1346*	AB3-D 698.8-699.0
1348	AB3 737.3-738.1

TABLE -3 CONTINUED.

	SOVITE			HORNBLENDITE			
Ref. No.	**1349**	**1350**	**1347**	**1402**	**1403**	**1351**	**1356**
Ag	1	<1	3	<1	3	<1	<1
Au							
As							
Ba	570	610	460	290	280	500	380
Be	6	3	7	23	27	7	20
Bi							
Co	10	11	13	55	49	35	38
Cr	<5	<5	<5	<5	<5	<5	12
Cu	26	35	17	167	300	12	70
Ga	50	39	29	115	78	98	115
Hg							
Li	10	8	9	4	8	3	3
Mn							
Mo	<3	<3	<3	<1	<1	<1	<1
Nb	350	200	1500	100	60	<30	60
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	30	<10	83	<10	50	<10	<10
Rb	30	20	10	<10	<10	10	10
Sb							
Sc	20†	9	6	15	15	45	5
Sn	6	6	14	41	30	8	38
Sr	4500	6000	9000	700	800	600	700
Ti							
V	150	100	200	300	350	350	500
Y	100	150	100	45	50	20	35
Zn	103	86	78	75	202	56	92
Zr	4500	1500	450	900	800	700	1000
La	350	400	350	100	100	<100	<100
Nd	210	230	200	180	190	60	140
Ce	460	460	420	240	260	60	220
Yb	9	10	10	2	2	1	2
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

† Zr interference.

Ref. No.	Sample No.	Ref. No.	Sample No.
1349	AB3 792.3-793.0	1403	A147 246.0-246.7
1350	AB3 847.0-847.6	1351	AB3 984.0-984.6
1347	AB3 701.8-702.5	1356	AB3 1142.8-1143.6
1402	A147 230.7-231.5		

TABLE A-3 CONTINUED.

	PYROXENITE					
Ref. No.	1335	1335*	1336	1404	1404*	1405
Ag	2		1	1		1
Au						
As						
Ba	230	230	280	350	380	260
Be	25		27	30		17
Bi						
Co	95	88	58	45	40	43
Cr	7	7	12	<5	<5	<5
Cu	640	625	660	280	240	330
Ga	74		72	96		80
Hg						
Li	4	5	4	6	8	4
Mn						
Mo	<1	<1	<1	<1	<1	<1
Nb	60	60	80	90	70	50
Ni	52	54	25	14	13	13
Pb	<10	<10	<10	<10	<10	<10
Rb	<10	<10	<10	<10	10	<10
Sb						
Sc	60	60	45	35	35	45
Sn	53		27	41		30
Sr	700	700	800	600	600	600
Ti						
V	350	400	350	350	300	350
Y	30	35	45	25	35	25
Zn	94	96	116	90	90	92
Zr	900	900	900	1500	1500	800
La	<100	<100	<100	<100	<100	<100
Nd	80	60	120	80	70	90
Ce	120	120	180	100	100	120
Yb	1	2	2	1	1	1
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

* Duplicate sample.

Ref. No.	Sample No.	Ref. No.	Sample No.
1335	A2 1122.8-1123.5	1404	A147 250.9-251.8
1335*	A2-D 1122.8-1123.5	1404*	A147-D 250.9-251.8
1336	A2 1183.0-1183.8	1405	A147 270.2-271.6

TABLE A-3 CONTINUED.

	PYROXENITE					
Ref. No.	**1352**	**1353**	**1354**	**1354***	**1355**	**1357**
Ag	<1	3	<1		<1	2
Au						
As						
Ba	320	180	490	500	660	310
Be	19	17	23		21	33
Bi						
Co	50	63	42	43	45	33
Cr	9	<5	<5	<5	<5	24
Cu	250	290	173	186	134	138
Ga	105	94	110		105	70
Hg						
Li	<3	<3	3	3	4	7
Mn						
Mo	<1	<1	<1	<1	<1	<1
Nb	<30	50	<30	<30	70	45
Ni	6	<5	<5	<5	<5	18
Pb	<10	<10	<10	<10	<10	25
Rb	10	<10	30	30	50	<10
Sb						
Sc	25	15	25	25	15	15
Sn	24	25	31		49	37
Sr	600	700	600	600	600	900
Ti						
V	400	450	250	250	400	300
Y	35	60	50	50	50	40
Zn	95	104	76	74	108	102
Zr	500	500	600	600	700	600
La	<100	150	<100	<100	150	<100
Nd	120	240	140	160	200	130
Ce	180	400	240	220	320	220
Yb	2	3	2	2	2	2
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

* Duplicate sample.

Ref. No.	Sample No.	Ref. No.	Sample No.
1352	AB3 1037.6-1038.7	1354*	AB3-D 1075.5-1076.1
1353	AB3 1040.2-1041.1	1355	AB3 1090.8-1091.6
1354	AB3 1075.5-1076.1	1357	AB3 1178.7-1179.2

TABLE A-3 CONTINUED.

	SILICOCARBONATITE					
Ref. No.	1331	1383	1368	1338	1333	1334
Ag	1	1	<1	1	1	1
Au						
As						
Ba	670	690	320	580	2600	380
Be	2	1	4	1	2	40
Bi						
Co	21	19	8	20	50	42
Cr	18	40	24	180	11	15
Cu	9	12	6	15	62	131
Ga	115	46	135	105	84	74
Hg						
Li	12	38	9	18	6	<3
Mn						
Mo	<3	<1	<3	<1	<1	<1
Nb	250	2500	80	200	300	250
Ni	<5	<5	<5	29	7	14
Pb	<10	140	<10	<10	<10	<10
Rb	150	140	80	190	80	10
Sb						
Sc	4	9	8	<5	10	40
Sn	12	3	2	<1	2	50
Sr	4500	1500	2500	2500	600	1500
Ti						
V	80	80	<10	35	100	500
Y	70	35	100	60	35	50
Zn	193	200	114	182	183	152
Zr	1000	600	1500	300	300	600
La	200	400	350	<100	<100	<100
Nd	170	150	250	60	80	120
Ce	320	420	420	140	160	200
Yb	4	2	3	3	1	2
Ta	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1331	A2 988.1-988.7	1338	AB3 443.2-443.4
1383	A137 318.6-318.8	1333	A2 1059.0-1059.7
1368	A8 843.6-844.0	1334	A2 1110.9-1111.6

TABLE A-4. NORMATIVE MINERALS (ALKALIC ROCKS) FOR WHOLE-ROCK SAMPLES FROM THE ARGOR CARBONATITE COMPLEX.

	SOVITE						
Ref. No.	1314	1315	1316	1317	1318	1319	1320
QZ	0.30	0.05	1.66	0.0	1.25	3.05	1.81
CO	0.39	0.24	0.10	0.08	0.0	0.0	0.09
OR	0.06	0.24	2.48	5.38	0.83	1.59	1.30
AB	0.0	0.0	0.52	0.0	1.53	0.76	0.0
LC	0.0	0.0	0.0	0.64	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	1.43	2.55	0.0
TH	0.11	0.73	0.75	0.60	0.84	1.46	1.19
GEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FA	11.14	10.33	4.10	5.80	4.90	4.59	6.55
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	0.84	2.09	1.64	1.66	1.13	1.68	4.49
SPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.03	0.04	0.07	0.20
AP	10.98	5.54	6.30	9.44	1.78	12.66	2.51
CC	42.60	45.86	70.79	61.42	76.70	57.87	71.33
MGS	26.88	27.72	8.61	12.02	5.86	8.92	6.25
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.34	0.85	0.44	0.39	1.21	0.23	0.42
SUM	93.65	93.63	97.39	97.47	97.48	95.45	96.15

QZ - Quartz; CO - Corundum; OR - Orthoclase; AB - Albite; LC - Leucite; KAL - Kalsilite; NEPH - Nepheline; CAR - Carnegieite; NS - Na_2SiO_3; AC - Acmite; TH - Thenardite; GEH - Gehlenite; AKM - Akermanite; FE-AK - Fe-Akermanite; D.WO - Wollastonite; D.EN - Enstatite; D.FS - Ferrosilite; FO - Forsterite; FA - Fayalite; ANDR - Andradite; HM - Hematite; MT - Magnetite; SPH - Sphene; PERV - Perovskite; RU - Rutile; AP - Apatite; CC - Calcite; MGS - Magnesite; FL - Fluorite; ZR - Zircon; BAD - Baddeleyite.

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1314	A2 172.9-173.2	1318	A2 467.3-467.6
1315	A2 254.5-254.7	1319	A2 519.7-520.0
1316	A2 366.7-367.1	1320	A2 569.6-570.0
1317	A2 409.3-409.6		

TABLE A-4 CONTINUED.

	SOVITE					
Ref. No.	1321	1322	1323	1324	1325	1326
QZ	3.93	2.03	0.0	2.97	2.73	1.33
CO	0.0	0.0	0.0	0.0	0.12	0.0
OR	1.69	0.89	8.85	8.23	1.77	0.71
AB	0.0	1.02	0.0	0.0	0.0	0.93
LC	0.0	0.0	5.29	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	0.0	0.0	0.0	0.0	0.0	0.0
CAR	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0
AC	3.23	0.34	1.81	0.10	0.0	0.41
TH	1.55	1.06	0.89	2.21	1.56	0.93
GEH	0.0	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	0.0	0.0	0.0	0.0	0.0
D.EN	0.0	0.0	0.0	0.0	0.0	0.0
D.FS	0.0	0.0	0.0	0.0	0.0	0.0
FO	1.58	0.0	6.39	2.98	0.0	0.0
FA	5.60	4.91	8.01	7.31	4.80	5.83
ANDR	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0
MT	0.76	2.65	2.34	0.87	1.64	0.28
SPH	0.0	0.0	0.0	0.0	0.0	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.17	0.05	0.14	0.04	0.04	0.55
AP	7.83	8.33	3.86	10.58	12.45	5.78
CC	64.09	71.26	50.02	53.88	65.22	74.16
MGS	8.01	4.96	7.80	8.95	5.75	5.21
FL	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.30	0.35	0.55	0.38	0.40	0.19
SUM	98.74	97.86	95.95	98.50	96.47	96.29

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1321	A2 609.2-609.5	1324	A2 731.2-731.5
1322	A2 662.7-663.0	1325	A2 784.2-784.5
1323	A2 708.2-708.5	1326	A2 852.7-852.9

TABLE A-4 CONTINUED.

	SOVITE						
Ref. No.	**1327**	**1328**	**1329**	**1330**	**1332**	**1381**	**1382**
QZ	0.0	2.89	1.93	0.0	3.33	0.0	3.02
CO	0.0	0.16	0.0	0.0	0.0	0.19	0.45
OR	8.99	3.36	2.36	0.0	1.36	0.0	0.30
AB	0.0	0.19	2.30	0.0	1.03	0.26	0.0
LC	1.93	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	9.79	0.0	0.0	0.0
NEPH	0.0	0.0	0.0	1.00	0.0	0.0	0.0
CAR	0.0	0.0	0.0	0.0	0.0	0.58	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	3.14	0.0	1.59	4.53	0.82	0.0	0.0
TH	0.09	1.46	0.97	0.53	1.46	0.53	1.47
GEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	29.51	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	31.46	0.0	0.0	0.0
D.WO	0.0	0.0	0.0	-19.27	0.0	0.0	0.0
D.EN	0.0	0.0	0.0	-10.41	0.0	0.0	0.0
D.FS	0.0	0.0	0.0	-13.15	0.0	0.0	0.0
FO	0.0	0.95	2.28	7.57	0.24	0.0	0.0
FA	9.41	4.47	5.73	10.56	5.39	11.46	5.18
ANDR	0.0	0.0	0.0	0.68	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	10.77	5.00	7.86	0.0	2.55	2.35	1.44
SPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERV	0.0	0.0	0.0	1.29	0.0	0.0	0.0
RU	0.12	0.55	0.84	0.0	0.21	0.03	0.09
AP	13.61	16.17	18.58	3.27	7.79	6.15	12.43
CC	25.55	59.92	49.15	26.58	66.10	45.61	59.00
MGS	25.42	4.44	5.48	0.0	9.91	26.26	10.96
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.29	0.33	0.14	0.84	0.20	0.22	0.31
SUM	99.33	99.89	99.21	84.79	100.38	93.64	94.63

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1327	A2 918.5-919.0	1332	A2 998.2-998.5
1328	A2 926.5-926.9	1381	A137 227.7-227.9
1329	A2 942.6-943.1	1382	A137 296.6-296.8
1330	A2 977.7-977.9		

TABLE A-4 CONTINUED.

	SOVITE					
Ref. No.	1384	1385	1390	1386	1387	1388
QZ	2.03	2.01	4.76	1.89	2.15	3.40
CO	0.24	0.35	0.14	0.11	0.00	0.21
OR	11.39	4.37	2.42	2.66	2.01	0.94
AB	0.34	0.0	0.0	0.0	1.48	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	0.0	0.0	0.0	0.0	0.0	0.0
CAR	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0
TH	2.04	1.74	2.68	1.79	1.64	1.92
GEH	0.0	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	0.0	0.0	0.0	0.0	0.0
D.EN	0.0	0.0	0.0	0.0	0.0	0.0
D.FS	0.0	0.0	0.0	0.0	0.0	0.0
FO	0.21	0.0	0.0	0.0	0.0	0.0
FA	7.32	7.87	7.21	7.62	6.10	6.21
ANDR	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0
MT	2.75	1.44	1.90	0.97	0.99	1.25
SPH	0.0	0.0	0.0	0.0	0.0	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.10	0.33	0.06	0.06	0.06	0.01
AP	14.98	10.98	6.06	10.89	12.66	5.99
CC	44.34	56.51	64.07	61.95	59.48	70.56
MGS	13.15	11.59	7.50	6.90	11.17	6.21
FL	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.41	0.29	0.42	0.25	0.25	0.30
SUM	99.30	97.47	97.22	95.09	97.98	97.00

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1384	A137 321.9-322.1	1386	A137 437.7-438.0
1385	A137 384.3-384.6	1387	A137 453.1-453.3
1390	A137 492.2-492.4	1388	A137 481.7-482.1

TABLE A-4 CONTINUED.

	SOVITE						
Ref. No.	**1389**	**1391**	**1392**	**1393**	**1394**	**1395**	**1396**
QZ	2.49	2.08	2.42	1.08	1.09	2.40	2.51
CO	0.22	0.17	0.13	0.10	0.15	0.0	0.11
OR	0.83	0.94	1.18	2.07	1.36	2.42	1.65
AB	0.0	0.0	0.0	0.0	0.0	0.34	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	1.81	0.0
TH	1.49	1.35	1.74	0.78	0.92	1.55	1.70
GEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FA	7.50	6.93	6.85	6.91	7.82	7.42	0.0
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	7.79
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	1.13	0.39	1.76	1.23	0.0	0.08	1.73
SPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.01	0.04	0.12	0.02	0.0	0.04	0.04
AP	8.24	3.81	6.08	7.72	2.13	5.56	2.79
CC	63.15	73.79	68.32	69.73	76.52	67.59	71.23
MGS	9.69	6.48	6.73	5.83	6.23	7.54	6.84
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.27	0.32	0.34	0.30	0.19	0.28	0.29
SUM	95.02	96.31	95.69	95.78	96.42	97.04	96.67

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1389	A137 488.0-488.3	1394	A137 578.0-578.3
1391	A137 516.2-516.5	1395	A137 589.1-589.3
1392	A137 531.5-531.9	1396	A137 609.3-609.6
1393	A137 559.3-559.6		

TABLE A-4 CONTINUED.

	SOVITE						
Ref. No.	1397	1398	1399	1400	1401	1406	1407
QZ	1.50	0.0	1.41	2.84	0.0	2.02	3.90
CO	0.21	0.0	0.14	0.10	0.12	0.0	0.24
OR	0.59	0.0	2.18	3.72	0.0	4.01	0.83
AB	0.0	0.0	0.0	1.01	0.0	1.61	0.0
LC	0.0	0.0	0.0	0.0	0.16	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.07	0.0	0.0
NEPH	0.0	0.12	0.0	0.0	1.06	0.0	0.0
CAR	0.0	0.69	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.03	0.0	0.0	0.0	0.0	0.0
AC	0.0	2.03	0.0	0.0	0.0	1.03	0.0
TH	0.80	0.40	1.08	1.95	0.53	1.24	1.44
GEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	5.06	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	-3.86	0.0	0.0	0.0	0.0	0.0
D.EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.FS	0.0	-4.40	0.0	0.0	0.0	0.0	0.0
FO	0.0	0.0	0.0	1.34	0.0	2.98	0.11
FA	6.14	15.15	8.47	6.29	11.18	5.48	3.77
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	0.36	0.0	4.65	1.19	1.35	6.15	3.14
SPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.18	0.06	0.02	0.79	0.10
AP	8.66	13.40	7.20	16.14	6.41	14.27	7.12
CC	70.40	41.81	61.69	56.02	53.73	56.45	71.93
MGS	6.38	23.55	7.92	6.76	18.11	2.78	4.48
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.22	0.30	0.41	0.24	0.35	0.38	0.27
SUM	95.27	94.27	95.33	97.67	93.09	99.20	97.32

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1397	A137 617.8-618.1	1401	A137 718.8-719.3
1398	A137 642.3-642.6	1406	A147 353.0-353.4
1399	A137 698.0-698.4	1407	A147 373.4-374.6
1400	A137 704.1-704.3		

TABLE A-4 CONTINUED.

	SOVITE						
Ref. No.	**1408**	**1409**	**1410**	**1411**	**1412**	**1413**	**1414**
QZ	3.52	4.06	3.53	2.42	4.06	2.16	4.56
CO	0.08	0.02	0.0	0.0	0.05	0.08	0.13
OR	2.24	2.60	1.77	0.83	1.89	1.89	2.72
AB	0.0	0.0	0.28	0.51	0.0	0.13	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	3.46	0.27	0.0	0.0	0.0
TH	1.72	1.97	2.48	1.11	1.67	1.68	1.92
GEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FO	0.33	0.32	3.17	0.14	0.0	2.14	0.07
FA	5.60	5.15	8.70	4.88	5.69	4.81	5.22
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	1.95	1.51	0.73	0.73	1.00	2.03	3.99
SPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.07	0.09	0.22	0.02	0.0	0.07	0.36
AP	6.65	11.67	18.87	1.85	12.38	6.30	17.18
CC	70.08	64.21	51.54	82.69	61.72	75.24	54.28
MGS	4.69	5.42	2.32	3.83	8.04	4.93	5.56
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.23	0.20	0.30	0.24	0.15	0.41	0.26
SUM	97.16	97.23	97.37	99.52	96.66	101.88	96.27

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1408	A147 405.7-406.1	1412	A147 501.6-502.2
1409	A147 412.9-413.3	1413	A147 523.2-523.6
1410	A147 461.8-462.2	1414	A147 532.5-532.9
1411	A147 473.8-474.2		

TABLE A-4 CONTINUED.

	SOVITE						
Ref. No.	1358	1359	1360	1361	1362	1363	1364
QZ	4.02	0.0	0.27	0.0	0.0	3.75	1.89
CO	0.34	0.29	0.38	0.24	0.0	0.16	0.33
OR	0.65	0.0	0.83	0.0	1.67	2.24	1.65
AB	0.15	0.0	0.0	0.0	0.09	0.0	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.37	0.0	0.0	0.0	0.0	0.0
NEPH	0.0	0.0	0.0	0.25	0.59	0.0	0.0
CAR	0.0	0.0	0.0	0.01	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	4.58	0.0	0.0
TH	1.82	0.85	1.05	0.75	0.0	1.92	1.10
GEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.82	0.0	1.55	0.0	0.0	0.0
D.WO	0.0	-0.63	0.0	-1.18	0.0	0.0	0.0
D.EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.FS	0.0	-0.71	0.0	-1.35	0.0	0.0	0.0
FO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FA	4.79	12.03	10.36	13.54	7.15	5.85	5.63
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	1.16	2.06	2.72	0.07	0.78	3.75	7.28
SPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.01	0.02	0.07	0.0	0.09	0.16	0.26
AP	8.71	5.30	10.96	7.76	6.89	6.30	11.53
CC	69.10	45.56	40.84	43.12	67.52	64.90	59.18
MGS	6.46	27.30	25.84	27.09	6.61	6.36	7.31
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.17	0.25	0.28	0.22	0.0	0.26	0.21
SUM	97.39	93.52	93.60	92.07	95.97	95.64	96.36

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1358	A8 266.3-266.8	1362	A8 407.7-408.3
1359	A8 309.3-309.6	1363	A8 418.5-418.9
1360	A8 323.3-323.6	1364	A8 455.9-456.3
1361	A8 363.6-364.0		

TABLE A-4 CONTINUED.

	SOVITE					
Ref. No.	**1365**	**1366**	**1366A**	**1367**	**1369**	**1370**
QZ	2.26	2.17	1.50	1.51	0.80	2.53
CO	0.21	0.10	0.0	0.16	0.17	0.13
OR	1.36	1.30	5.34	0.35	1.12	7.02
AB	0.0	0.0	0.0	0.0	0.0	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	0.0	0.0	0.0	0.0	0.0	0.0
CAR	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0
TH	1.24	0.55	0.60	0.39	0.41	1.12
GEH	0.0	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	0.0	0.0	0.0	0.0	0.0
D.EN	0.0	0.0	0.0	0.0	0.0	0.0
D.FS	0.0	0.0	0.0	0.0	0.0	0.0
FO	0.0	0.0	0.33	0.0	0.0	0.0
FA	6.33	2.93	3.80	3.40	3.57	4.90
ANDR	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0
MT	0.84	1.84	3.59	0.23	0.0	1.42
SPH	0.0	0.0	0.0	0.0	0.0	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.02	0.03	0.01	0.0	0.0	0.02
AP	6.49	9.26	9.70	0.47	10.96	8.52
CC	71.85	74.81	62.23	83.70	75.43	60.20
MGS	6.38	6.48	12.24	7.59	4.75	9.75
FL	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.27	0.12	0.19	0.25	0.20	0.31
SUM	97.24	99.59	99.53	98.04	97.42	95.93

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1365	A8 476.2-476.6	1367	A8 832.2-832.7
1366	A8 732.1-732.3	1369	A8 880.8-881.2
1366A	A8 740.6-741.0	1370	A8 889.0-889.4

TABLE A-4 CONTINUED.

	SOVITE						
Ref. No.	1371	1372	1373	1374	1375	1376	1377
QZ	2.43	1.67	4.93	1.94	0.22	2.50	2.69
CO	0.18	0.0	0.0	0.05	0.09	0.09	0.10
OR	0.35	0.47	2.67	4.37	3.54	1.59	2.12
AB	0.0	0.69	0.0	0.0	0.0	0.0	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	1.47	0.0	0.0	0.0	0.0	0.0
TH	0.92	0.53	1.88	0.71	0.23	0.99	1.21
GEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FO	0.0	0.48	0.0	0.0	0.0	0.0	0.0
FA	3.85	4.99	3.89	4.28	4.73	4.51	4.94
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	4.76	5.50	3.27	2.12	0.20	2.91	6.12
SPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.01	0.19	0.03	0.02	0.0	0.11	0.20
AP	4.69	4.85	16.12	12.78	13.21	8.02	7.83
CC	73.45	71.15	55.16	61.32	67.14	68.36	64.09
MGS	7.21	5.51	8.79	6.63	5.98	7.75	8.79
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.22	0.35	0.21	0.16	0.23	0.21	0.33
SUM	98.07	97.84	96.96	94.38	95.57	97.03	98.44

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1371	A8 932.8-933.3	1375	A8 1036.5-1037.0
1372	A8 939.4-939.8	1376	A8 1081.3-1081.6
1373	A8 977.6-978.1	1377	A8 1098.4-1098.8
1374	A8 998.7-999.1		

TABLE A-4 CONTINUED.

	SOVITE						
Ref. No.	**1378**	**1379**	**1380**	**1337**	**1339**	**1340**	**1341**
QZ	2.65	3.66	0.0	0.39	0.68	0.45	1.65
CO	0.0	0.0	0.0	0.13	0.0	0.06	0.18
OR	2.72	1.89	0.0	2.24	0.41	0.47	0.47
AB	0.17	0.38	0.0	0.0	1.97	1.30	0.03
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	0.0	0.0	0.25	0.0	0.0	0.0	0.0
CAR	0.0	0.0	0.54	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	2.49	0.19	0.49	0.0	0.71	0.0	0.0
TH	0.93	1.37	0.22	0.53	0.58	0.93	0.89
GEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.74	0.0	0.0	0.0	0.0
D.WO	0.0	0.0	-0.56	0.0	0.0	0.0	0.0
D.EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.FS	0.0	0.0	-0.64	0.0	0.0	0.0	0.0
FO	0.35	0.75	0.0	0.0	0.0	0.0	0.0
FA	4.92	4.40	9.86	4.38	6.72	7.03	4.99
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	4.17	5.02	0.22	0.0	1.46	0.64	0.44
SPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.14	0.22	0.0	0.0	0.0	0.04	0.0
AP	10.39	10.91	7.39	8.36	21.54	9.21	1.37
CC	60.66	61.21	44.56	71.60	36.94	47.37	81.02
MGS	8.98	7.94	30.84	6.19	25.21	26.67	6.25
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.18	0.17	0.27	0.17	0.12	0.18	0.22
SUM	98.74	98.12	94.17	93.99	96.35	94.55	97.51

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1378	A8 1137.8-1138.3	1339	AB3 472.2-472.4
1379	A8 1148.4-1148.7	1340	AB3 485.8-486.0
1380	A8 1197.6-1198.0	1341	AB3 538.2-538.4
1337	AB3 432.2-432.4		

TABLE A-4 CONTINUED.

	SOVITE					
Ref. No.	1342	1343	1344	1345	1346	1348
QZ	2.79	2.01	3.30	4.69	2.36	3.61
CO	0.0	0.0	0.12	0.11	0.15	0.0
OR	0.41	2.83	1.71	3.31	3.01	3.78
AB	1.10	0.26	0.0	0.0	0.0	1.63
LC	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	0.0	0.0	0.0	0.0	0.0	0.0
CAR	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.08	0.24	0.0	0.0	0.0	2.01
TH	1.42	0.89	1.81	2.20	1.01	1.46
GEH	0.0	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	0.0	0.0	0.0	0.0	0.0
D.EN	0.0	0.0	0.0	0.0	0.0	0.0
D.FS	0.0	0.0	0.0	0.0	0.0	0.0
FO	0.0	0.0	0.0	1.11	1.34	0.68
FA	4.79	4.70	6.23	5.27	3.99	5.68
ANDR	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0
MT	0.41	1.16	2.35	3.76	5.22	4.27
SPH	0.0	0.0	0.0	0.0	0.0	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.02	0.74	0.54	0.49	0.43
AP	7.67	10.49	7.36	18.70	12.36	15.86
CC	70.67	68.06	66.34	50.28	63.88	54.88
MGS	6.02	5.90	5.73	7.77	4.74	5.24
FL	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.16	0.24	0.25	0.25	0.14	0.29
SUM	95.52	96.79	95.95	97.99	98.69	99.82

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1342	AB3 578.2-578.4	1345	AB3 643.2-643.4
1343	AB3 594.3-594.5	1346	AB3 698.8-699.0
1344	AB3 628.2-628.4	1348	AB3 737.3-738.1

TABLE A-4 CONTINUED.

	SOVITE			HORNBLENDITE			
Ref. No.	**1349**	**1350**	**1347**	**1402**	**1403**	**1351**	**1356**
QZ	2.63	3.23	4.62	7.12	10.20	0.0	7.93
CO	0.0	0.0	0.26	0.0	0.0	0.0	0.0
OR	5.31	4.31	2.66	5.31	4.66	8.79	7.55
AB	0.44	1.08	0.33	6.52	5.26	14.94	8.27
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	0.0	0.0	0.0	0.0	0.0	3.99	0.0
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.66	0.24	0.0	0.0	0.0	0.0	0.0
TH	1.42	1.33	1.95	2.75	2.79	0.09	2.57
GEH	0.0	0.0	0.0	17.92	15.51	15.29	17.45
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	0.0	0.0	0.0	0.0	4.13	1.62
D.EN	0.0	0.0	0.0	0.0	0.0	2.81	0.94
D.FS	0.0	0.0	0.0	0.0	0.0	0.98	0.60
FO	1.14	1.63	0.76	20.14	19.62	23.04	15.23
FA	6.19	5.43	4.71	9.15	10.59	8.27	10.69
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0	0.0
MT	6.28	4.80	6.03	7.45	4.34	3.49	6.97
SPH	0.0	0.0	0.0	4.79	2.95	9.32	7.11
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.58	0.71	0.43	2.39	1.56	0.0	0.0
AP	16.52	16.45	12.57	10.51	14.75	0.14	9.30
CC	54.04	55.18	61.35	3.48	6.07	2.32	3.50
MGS	3.85	4.42	3.81	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.26	0.35	0.50	1.13	1.10	0.59	0.79
SUM	99.32	99.17	99.98	98.66	99.39	98.77	100.53

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1349	AB3 792.3-793.0	1403	A147 246.0-246.7
1350	AB3 847.0-847.6	1351	AB3 984.0-984.6
1347	AB3 701.8-702.5	1356	AB3 1142.8-1143.6
1402	A147 230.7-231.5		

TABLE A-4 CONTINUED.

	PYROXENITE				
Ref. No.	1335	1336	1404	1405	1352
QZ	6.68	7.39	3.78	4.06	7.20
CO	0.0	0.0	0.0	0.0	0.0
OR	2.24	2.24	5.90	3.66	5.78
AB	0.0	0.0	10.33	5.75	5.38
LC	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0
NEPH	0.0	0.0	0.0	0.0	0.0
CAR	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0
TH	2.75	2.66	1.46	1.33	2.39
GEH	7.90	8.46	13.03	10.00	15.03
AKM	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0
D.WO	15.26	10.53	6.40	15.44	4.21
D.EN	9.84	6.80	4.29	10.12	2.57
D.FS	4.38	3.01	1.62	4.21	1.41
FO	15.52	14.17	20.44	16.02	16.78
FA	7.63	6.93	8.54	7.37	10.13
ANDR	0.0	0.0	0.0	0.0	0.0
HM	7.80	2.47	0.0	5.08	0.0
MT	0.0	7.29	6.07	0.0	7.26
SPH	6.87	9.62	8.17	7.09	10.08
PERV	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0
AP	0.50	3.86	0.85	1.07	10.34
CC	12.57	13.63	7.07	8.07	1.91
MGS	0.0	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0
H_2O	0.46	0.33	1.00	0.63	0.28
SUM	100.39	99.40	98.95	99.87	100.76

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1335	A2 1122.8-1123.5	1405	A147 270.2-271.6
1336	A2 1183.0-1183.8	1352	AB3 1037.6-1038.7
1404	A147 250.9-251.8		

TABLE A-4 CONTINUED.

	PYROXENITE				SILICO-CARBON-ATITE
Ref. No.	**1353**	**1354**	**1355**	**1357**	**1331**
QZ	7.18	7.74	6.95	11.70	0.0
CO	0.0	0.0	0.0	0.0	0.08
OR	3.84	5.43	7.20	0.77	12.55
AB	0.0	1.32	0.0	0.08	0.0
LC	0.0	0.0	0.0	0.0	9.94
KAL	0.0	0.0	0.0	0.0	0.0
NEPH	0.0	0.0	0.0	0.0	5.42
CAR	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0
TH	2.22	1.77	1.86	2.61	0.18
GEH	12.16	11.47	10.21	12.86	0.0
AKM	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	9.92	6.09	20.37	0.0
D.EN	0.0	6.47	3.65	11.95	0.0
D.FS	0.0	2.75	2.11	7.40	0.0
FO	13.48	14.05	14.10	6.67	8.31
FA	13.95	6.61	8.99	4.56	14.22
ANDR	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	2.86	0.0
MT	7.99	6.42	7.84	0.0	2.76
SPH	6.07	10.25	10.82	4.56	0.0
PERV	0.0	0.0	0.0	0.0	0.0
RU	4.77	0.0	0.0	0.0	1.06
AP	25.33	12.73	17.09	10.70	10.04
CC	1.59	1.59	2.09	2.91	28.20
MGS	0.0	0.0	0.0	0.0	2.08
FL	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0
H_2O	0.31	0.66	0.44	0.75	1.20
SUM	98.89	99.20	99.45	100.75	96.03

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1353	AB3 1040.2-1041.1	1357	AB3 1178.7-1179.2
1354	AB3 1075.5-1076.1	1331	A2 988.1-988.7
1355	AB3 1090.8-1091.6		

TABLE A-4 CONTINUED.

	SILICOCARBONATITE				
Ref. No.	1383	1368	1338	1333	1334
QZ	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.41	1.14	0.0
OR	4.04	0.0	0.0	0.0	2.03
AB	0.0	0.0	0.0	0.0	10.06
LC	24.29	16.35	22.34	19.12	0.0
KAL	0.0	1.06	3.63	5.20	0.0
NEPH	0.23	0.27	0.0	3.09	5.15
CAR	0.0	0.0	0.0	0.0	0.0
NS	0.54	0.0	0.0	0.0	0.0
AC	8.68	0.80	0.0	0.0	2.78
TH	0.22	0.04	0.18	0.80	0.89
GEH	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	0.0	0.0	0.0	3.39
D.EN	0.0	0.0	0.0	0.0	2.11
D.FS	0.0	0.0	0.0	0.0	1.07
FO	16.27	10.85	14.61	23.51	16.24
FA	14.05	5.76	12.32	12.29	9.07
ANDR	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0
MT	0.0	0.80	1.76	2.76	12.70
SPH	0.0	0.0	0.0	0.0	10.25
PERV	0.0	0.0	0.0	0.0	0.0
RU	0.56	0.05	0.72	3.13	0.0
AP	5.80	16.43	2.72	1.56	3.74
CC	15.82	29.17	30.29	20.74	18.63
MGS	7.57	16.15	5.59	1.59	0.0
FL	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0
H_2O	0.83	0.79	1.39	0.27	0.61
SUM	98.89	98.53	95.98	95.20	98.72

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1383	A137 318.6-318.8	1333	A2 1059.0-1059.7
1368	A8 843.6-844.0	1334	A2 1110.9-1111.6
1338	AB3 443.2-443.4		

TABLE A-5. AVERAGE CHEMICAL COMPOSITIONS* (WEIGHT PERCENT AND PPM) OF LITHOLOGIC UNITS FOR THE ARGOR CARBONATITE COMPLEX.

	Sovite (N = 90)		Hornblendite (N = 4)	
	Mean	Std. Deviation	Mean	Std. Deviation
SiO_2	6.32	2.59	35.25	3.98
Al_2O_3	0.67	0.54	9.41	1.65
Fe_2O_3	1.79	1.53	3.83	1.34
FeO	4.56	1.51	8.69	0.86
MgO	4.86	3.22	11.61	2.15
CaO	39.76	5.14	16.17	2.76
Na_2O	0.64	0.27	2.09	0.26
K_2O	0.46	0.54	1.19	0.46
TiO_2	0.16	0.23	3.45	0.75
P_2O_5	4.02	1.87	3.67	2.60
MnO	0.60	0.20	0.16	0.03
CO_2	33.30	4.86	1.69	0.70
S	0.40	0.21	0.46	0.30
H_2O+	0.04	0.14	0.68	0.21
H_2O-	0.25	0.09	0.23	0.08
LOI	31.42	4.73	2.50	0.58
TOTAL	97.97	1.13	98.60	0.85
S.G.	2.92	0.07	3.20	0.05
Ag	0.76	3.57	0.00	2.00
Co	10.90	6.16	44.25	9.36
Cr	<2.90	5.78	<0.75	8.50
Cu	10.75	7.68	137.25	125.94
Li	8.72	2.32	4.50	2.38
Ni	<4.79	1.93	<5.00	0.00
Pb	12.60	28.03	5.00	30.00
Zn	63.53	66.01	106.25	65.51
Be	1.70	4.89	19.25	8.66
Mo	<2.62	3.54	<1.00	0.00
Sc	5.66	8.63	20.00	17.32
Sr	4724.53	3299.14	700.00	81.65
V	48.05	52.61	375.00	86.60
Y	128.97	33.03	37.50	13.23
Ga	30.30	36.20	101.50	17.60
Nb	3125.12	2829.16	47.50	55.00
Rb	9.08	22.65	0.00	11.55
Zr	343.23	791.15	850.00	129.10
Ta	<0.10	0.00	<0.10	0.00
Sn	9.76	9.44	28.00	14.12
Ba	398.05	165.20	362.50	102.10
Yb	8.50	2.76	1.75	0.50
Ce	390.27	73.42	195.00	91.47
La	373.89	96.64	0.00	115.47
Nd	194.00	43.36	142.50	59.09

*The average compositions may include duplicate samples or analyses which are not listed in Tables A-2 to A-4.

TABLE A-5. CONTINUED.

	Pyroxenite (N = 13)		Silicocarbonatite (N = 7)	
	Mean	Std. Deviation	Mean	Std. Deviation
SiO_2	35.36	4.40	24.96	4.94
Al_2O_3	5.42	1.59	6.18	1.50
Fe_2O_3	5.40	1.55	2.92	3.07
FeO	8.66	1.41	6.35	4.18
MgO	11.13	1.94	10.59	3.60
CaO	19.68	2.48	18.36	4.91
Na_2O	1.19	0.36	1.04	0.91
K_2O	0.76	0.36	4.55	1.85
TiO_2	3.80	1.29	1.54	1.52
P_2O_5	2.95	2.78	3.04	2.23
MnO	0.18	0.02	0.29	0.02
CO_2	2.53	2.08	13.37	4.38
S	0.61	0.30	0.12	0.11
H_2O+	0.34	0.23	0.64	0.47
H_2O-	0.23	0.06	0.54	0.78
LOI	2.64	1.65	14.24	4.84
TOTAL	98.97	0.75	96.91	1.53
S.G.	3.30	0.08	3.06	0.18
Ag	0.60	1.51	<0.71	0.76
Co	53.75	19.39	26.67	15.90
Cr	2.00	9.66	48.00	65.46
Cu	328.83	198.01	39.17	49.57
Li	3.50	3.40	13.33	13.94
Ni	14.58	20.64	5.83	13.83
Pb	<7.08	10.10	15.00	61.24
Zn	94.75	12.07	170.67	32.25
Be	23.30	5.42	7.57	14.34
Mo	<1.00	0.00	<1.67	1.03
Sc	33.33	16.28	11.00	15.23
Sr	666.67	98.47	2183.33	1342.26
V	345.83	62.01	130.83	185.16
Y	39.17	11.84	58.33	24.63
Ga	89.20	14.88	97.00	30.71
Nb	40.42	44.34	596.67	935.45
Rb	5.00	21.11	108.33	64.32
Zr	833.33	344.66	716.67	462.24
Ta	<0.10	0.00	<0.10	0.00
Sn	35.40	9.94	11.29	17.75
Ba	349.17	138.92	873.33	859.29
Yb	1.77	0.60	2.71	1.11
Ce	203.08	96.21	282.86	117.43
La	<42.31	109.63	121.43	219.58
Nd	130.00	56.42	142.86	63.70

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← S 81° W

N 81° E →

TEST SHAFT 57' NORTH

OVERBURDEN

LOWER DEVONIAN SEDIMENTS

MUCK SAMPLES IN ROCK 6 AV 0.83% Cb_2O_5

CROSSCUT AND SHAFT MUCK SAMPLES IN ROCK 5 AV 0.50% Cb_2O_5

107 1 115 114 152 2 9

200'

400'

600'

GEOLOGICAL SECTION 00
(LOOKING NORTH)

← S 81° W

147 128 127 126 125

OVERBURDEN

LOWER DEVONIAN SEDIMENTS

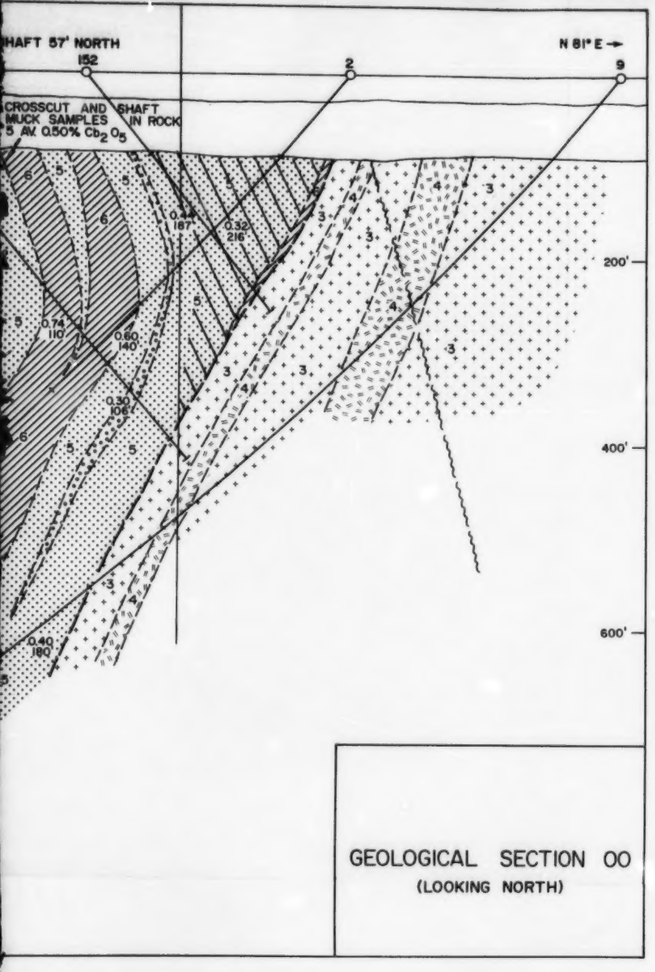
BASELINE

8S 4S 00 4N 8N 12N

SECTION 00

SECTION 8N

101 203 204 102 5 112 105 107 111 103 201 118 213 121 124 128 131 134 135 210 146 147 139 138



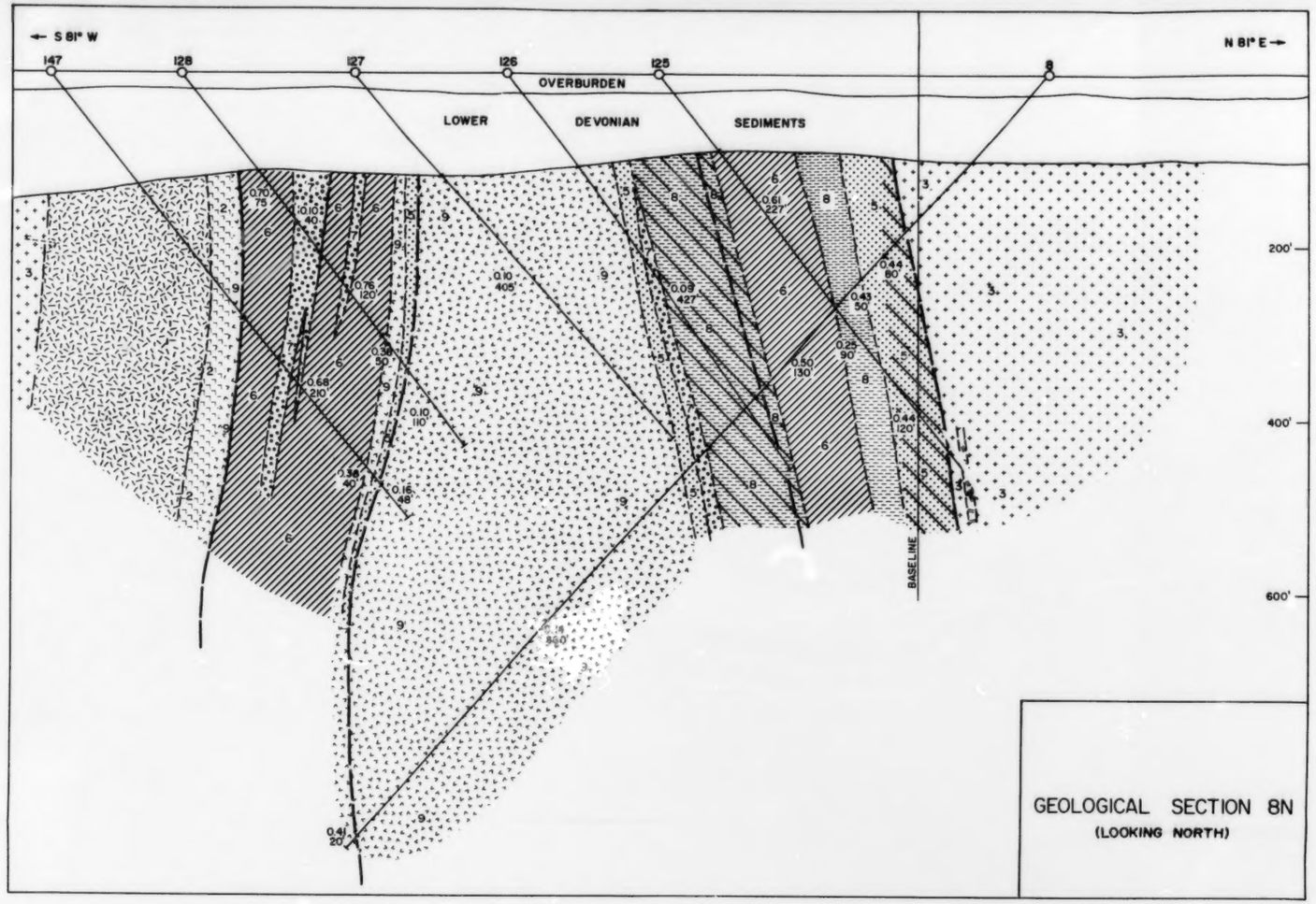


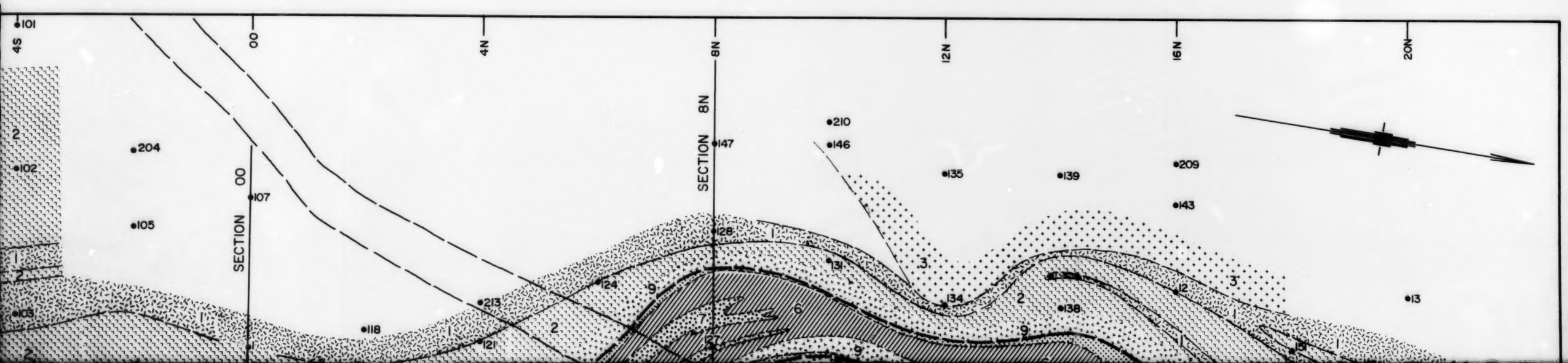
Chart A — Argor Carbonatite Complex

Figure 3. (bottom) Geological map of Argor Carbonatite Complex. Geology from files of Argor Explorations Ltd. (Stockford 1970, 1972).

Figure 4. (top left) Geological section of the Argor complex. Section 00 (looking north). From Stockford (1970, 1972).

Figure 5. (top right) Geological section of the Argor complex. Section 8N (looking north). From Stockford (1970, 1972).

Scale 1 inch to 100 feet (1:1200).



SECTION 00

SECTION 8N

SHAFT

South Bluff Creek

- LEGEND -

1	Pyroxenite
2	Barren Carbonatite
3	Gneiss
4	Metagabbro
5	Lineated dolomite host
6	Calcite-dolomite breccia host
7	Massive calcite or dolomite, low in mafics
8	Crushed dolomite host
9	Low grade carbonatite
	Columbite mineralization

B.L.

MAIN PYROCHLORE ZONE

Fault

Drill hole location

Shaft and crosscut

Main pyrochlore zone

8S 4S 00 4N 8N 12N

ARGOR CARBONATITE COMPLEX

GEOLOGICAL PLAN

SECTION 00

SECTION 8N

SHAFT

South Bluff Creek

B.L.

4S 00 4N 8N 12N 16N

20N

Fault

Drill hole location

Shaft and crosscut

Main pyrochlore zone

SCALE 0 100 200 300 FEET